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COMPOSITION, MICROGEOGRAPHIC VARIATION, AND SEXUAL DIMORPHISM IN CAATINGAS AND CERRADO BAT COMMUNITIES FROM NORTHEAST BRAZIL

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ABSTRACT

Although the South American tropics contains the most diverse chiropteran fauna in the world, most information concerning bats from this region is of a taxonomic or distributional nature. Further, most of our knowledge of Neotropical biology is restricted to locales within mesic predictable biomes. The Brazilian Northeast is an extensive tropical semiarid region characterized by climatic unpredictability and topographic heterogeneity, yet its fauna has never been studied. An 18 month field study of chiropteran populations in Caatingas and Cerrado communities of the Northeast revealed individual, secondary sexual, and microgeographic variation in the bat fauna. Study sites were restricted in size to reduce the probability of sampling bats from different communities while intensive monthly sampling regimes were established to define the faunal composition of each community.

Despite their geographic proximity, the Caatingas and Cerrado contain strikingly different faunas both taxonomically and ecologically. This disparity is most clearly exemplified by the insectivore guilds in each biome. Two hypotheses are proposed to account for the greater diversity of the Caatingas: 1) Large mesic enclaves (serrotes) are common in the Caatingas and probably insulate the fauna from the adverse effects of climatic vicissitudes, whereas great spatial heterogeneity produces distinct habitats for differential exploitation by different bat species, and 2) low insect abundance and diversity on the Chapada as well as reduced canopy complexity within habitats diminishes the number of insectivore niches available within the Cerrado.

Statistical analyses based on 14 external and 16 cranial measurements showed that many species with at least moderate sample sizes display sexual dimorphism, whereas interdemic variation between Caatingas and Cerrado populations is somewhat rarer. The applicability of various hypotheses concerning sexual dimorphism in bats is reviewed in light of the observation that females are larger than males in many bat species. Significant geographic variation between adjacent populations of highly mobile species is maintained in many bat species in the Brazilian Northeast.

INTRODUCTION

The American tropics contains the richest microchiropteran fauna in the world (Patterson and Pascual, 1968). The suborder contains 28.8% of all genera and 27.4% of all species of mammals found in the Neotropics (Walker, 1975). In the more favorable parts of their range, bats may dominate the mammal fauna in terms of both density and species richness (Hershkovitz, 1972). Fifty-two percent of the Costa Rican mammal fauna is composed of bats (Robinson, 1971); similarly, bats represent 46% of the Panamanian mammal fauna (Handley, 1966). In sharp contrast to the situation in the Neotropics, bats represent only 12% of Nearctic mammal species (Walker, 1964). The disparity between northern and southern continents, and the high degree of endemism in the Neotropical bat fauna may be attributed in part to biogeographic conditions. South America, existing as an island from the Cretaceous to late Cenozoic (Dietz and Holden, 1970) would offer great opportunity for chiropteran radiation. The later connection of South America with North America would account in part for the recent occupancy of tropical North America by bats, whereas the subsequent paucity of microchiropteran species might be caused, for the most part, by the vagaries of temperate zone climates.

The taxonomic diversity of Neotropical bats is paralleled by a similar diversity of feeding forms. The year-round abundance of fruits, seeds, nectar, insects and other animals provides sustenance for bats of diverse dietary specializations. Indeed, the adaptive radiation of bats seems to have evolved around the exploitation of many types of food and the partitioning of particular food items by size within general categories (McNab, 1971; Smith and Genoways, 1974). Thus, Neotropical bats occupy a variety of different food niches (frugivory, piscivory, nectarivory, carnivory, insectivory and sanguinivory), whereas Nearctic bats are primarily insectivorous (McNab, 1971; Fleming et al., 1972).

Simpson (1964) was the first to quantify the increase in the number of mammal species as latitude decreases from 60° N latitude to the equator, while MacArthur (1965) attempted to define the factors affecting species diversity to account for the increased richness observed in the tropics. More recently, J. Wilson (1974) has shown that Simpson's original observations are an artifact caused by an exponential increase in the number of bat species with decreasing latitude (see also Mares and Ojeda, 1982). Despite the significant contribution of bats to Neotropical diversity, few works other than the investigations of Flemming et al. (1972), Thomas (1972), and Heithaus et al. (1975) have considered diversity within chiropteran communities. Nonetheless, communities are the context in which species survive and evolve (Whittaker, 1975) and a firm understanding of Neotropical diversity gradients is predicated upon an adequate delineation of the faunal composition of restricted areas within the Neotropics. Many surveys of bat faunas have been made throughout South America, but most have dealt with large geopolitical units (e.g. Husson, 1962; Tuttle, 1970; Handley, 1976; Koopman, 1978). The fauna of broad geographic regions is the sum of the various communities that they contain; however, the differences between communities within a particular biome cannot, in general, be ascertained from such widespread collecting procedures.

Biomes as distinctive as the Caatingas and Cerrado would be expected to harbor unique faunas. Further, due to the unpredictable and severe climatic conditions characteristic of the Caatingas, it would be expected to support a diminished or depauperate fauna when compared to Cerrado habitats. The close proximity of these biomes in the Exu-Crato region of Brazil would effectively eliminate dispersal as a factor affecting the presence or absence of a particular species and thus, climatic or ecological factors should remain as important limiting agents.

Like the previously considered studies of faunal composition, chiropteran systematic studies usually deal with morphometric variation within relatively large areas containing a number of potentially different populations. It is therefore difficult to resolve individual and interdemic variation because samples from particular populations within an area are unidentified or are usually small in size and not amenable to statistical analyses. Further, few comprehensive statistical analyses of chiropteran variation appear in the literature; the works of Taddei (1975a, 1975b, 1979) are an obvious exception for the Phyllostomidae. This study defines and analyzes individual, secondary sexual, and geographic variation of specimens from the Brazilian Northeast. The variation herein reported for bats from both Caatingas and Cerrado populations represents true intrademic variation and the statistical analyses (two-way analysis of variance) permit the isolation of both interdemic and secondary sexual variation, with the subsequent assessment of statistical significance facilitated for each factor.

GENERAL DESCRIPTION OF THE CAATINGAS

The Northeast of Brazil contains five major vegetation zones (see Mares et al., 1981, for a brief description of each zone). Although I was able to make limited surveys in three of these (Atlantic Rainforest, Palm Forest, and Caatinga-Cerrado Contact Zones), the research considered herein is restricted to the Caatingas and Cerrado habitats, where I was able to conduct intensive field work.

The Caatingas (Fig. 1) is an extensive semiarid region lying between 35° and 45° west longitude and 3° and 16° south latitude (Reis, 1976). It occupies approximately 650,000 km^2 (Frota-Pessoa et al., 1971) and is characterized by extreme temporal and spatial climatic variability (Markham, 1972; Markham and McLain, 1977). Annual rainfall may reach 1,600 mm in some areas, yet during drought years other localities may not receive any precipitation at all (Melo, 1956; Markham, 1972). Although cyclic characteristics have been suggested (Markham, 1972, 1974, 1975; and Markham and McLain, 1977), more recent analyses utilizing highly sophisticated statistical techniques indicate that the pattern of rainfall is truly random. As such, the Caatingas has been called the "zone of calamity" (Freise, 1938) and the "region of anomalous drought" (Markham, 1972). Streilein (1981) has succinctly summarized the climatic attributes of the Caatingas. It is sufficient here to note that the variability and distribution of rainfall in the Caatingas is affected by the interrelationships between the Southeast Trade Winds (xeric inducing agents) and three large, mobile, moisture-laden air masses—the equitorial continental mass, the Intertropical Convergence Zone, and the South Atlantic Anticyclone. Precipitation is further affected and diminished by the complex and irregular pattern of orographic barriers (Fig. 2).

Three major geological elements account for the marked topographic relief of the Caatingas (Ab'Saber, 1970). The most extensive component is the basement layer of pre-Cambrian crystalline rock which produces extensive flatlands and gradual slopes. Numerous granitic protrusions in the form

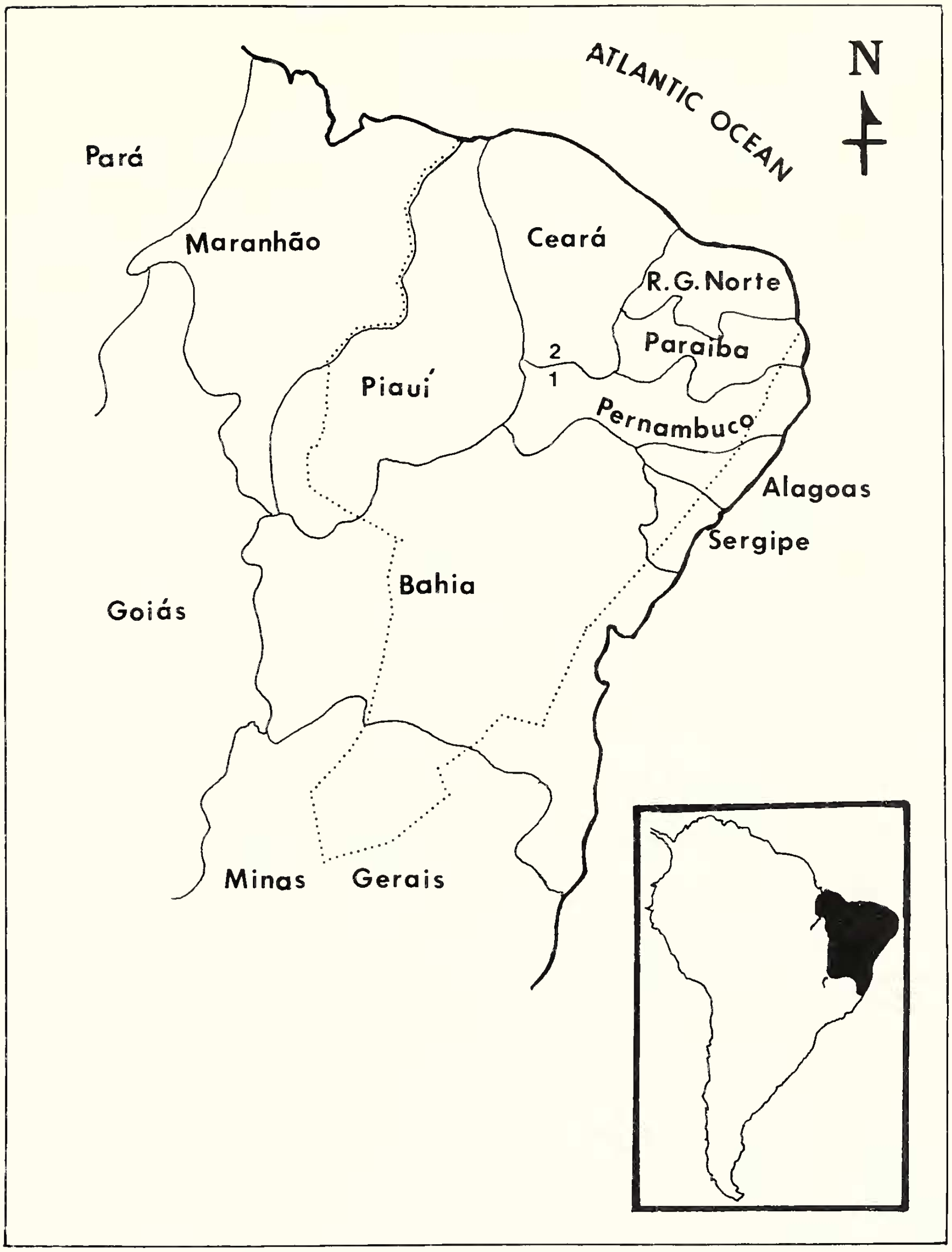

Fig. 1.—The Brazilian Caatingas (delimited by the dotted line) occupies an area of over 650,000 km^2 and is contained within nine states of the Northeast. Because of its irregular shape and susceptibility to extended periods of drought, the region is known as "o poligono das secas" (the polygon of drought). Numbers indicate the location of Caatingas (1) and Cerrado (2) study sites (modified from Mares et al., 1981).

of low mountain ranges (serras), small mountain ridges (serrotes), or lowland outcroppings (lajeiros) punctuate the otherwise flat surface and appreciably increase habitat complexity within the Caatingas. In areas unaffected by post-Cretaceous erosion, the original sandstone substrate still covers the crystalline basement and produces large mesa-like plateaus or chapadas (James, 1942; Ab'Saber, 1970). The elemental composition of these sandstone chapadas, in conjunction with their unique hydrological prop-

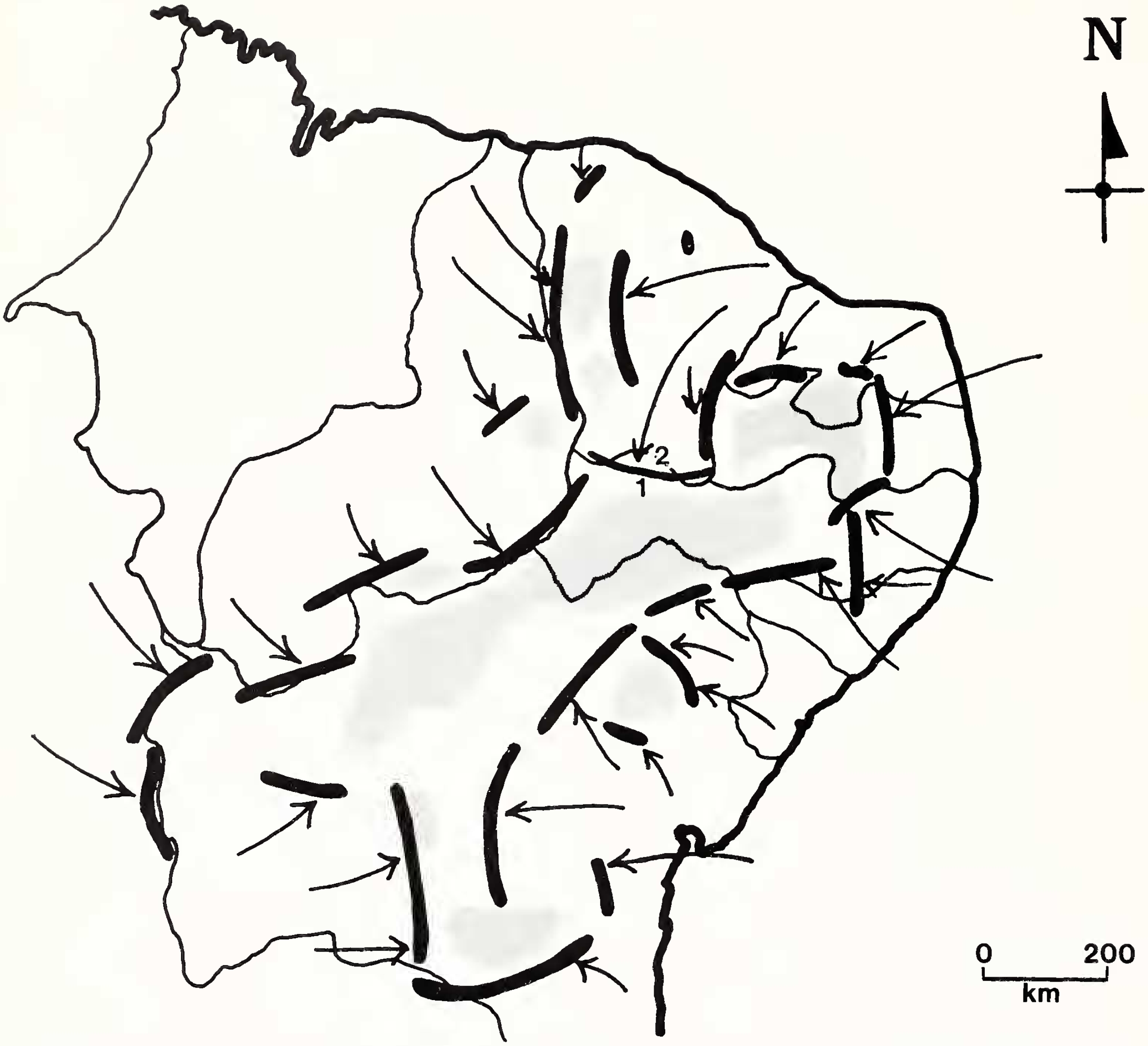

Fig. 2.—The windward side of large chapadas and serrotes (indicated by thick black lines) receive appreciable amounts of orographic rainfall due to the adiabatic cooling of rising air currents (arrows). This produces a rain shadow throughout the interior of the Northeast (shaded area) which is unpredictably subject to periods of severe drought (adapted from Markham, 1972). The Caatingas collection site (1) is located within the rain shadow whereas the Cerrado site (2) is on the windward side of the Chapada do Araripe.

erties, results in extensive edaphic Cerrado habitats occurring in various locations throughout the Northeast.

The zoogeographic affinities of the Caatingas fauna are unclear. Although a prominent biogeographic role has been ascribed to the region (Haffer, 1979; Simpson and Haffer, 1978), Sick (1965), Vanzolini (1974, 1976), Steilein (1981), and Mares et al. (1981) have indicated extremely low levels of vertebrate endemism in both the Caatingas and interdigitating Cerrado habitats.

In general, the mammal faunas of the Caatingas and Cerrado appear to be quite similar (Guimaraes, 1972), with elements from the Amazon Basin, Atlantic Rainforest and the Chaco xeric belt composing the major portion of each fauna. An analysis of

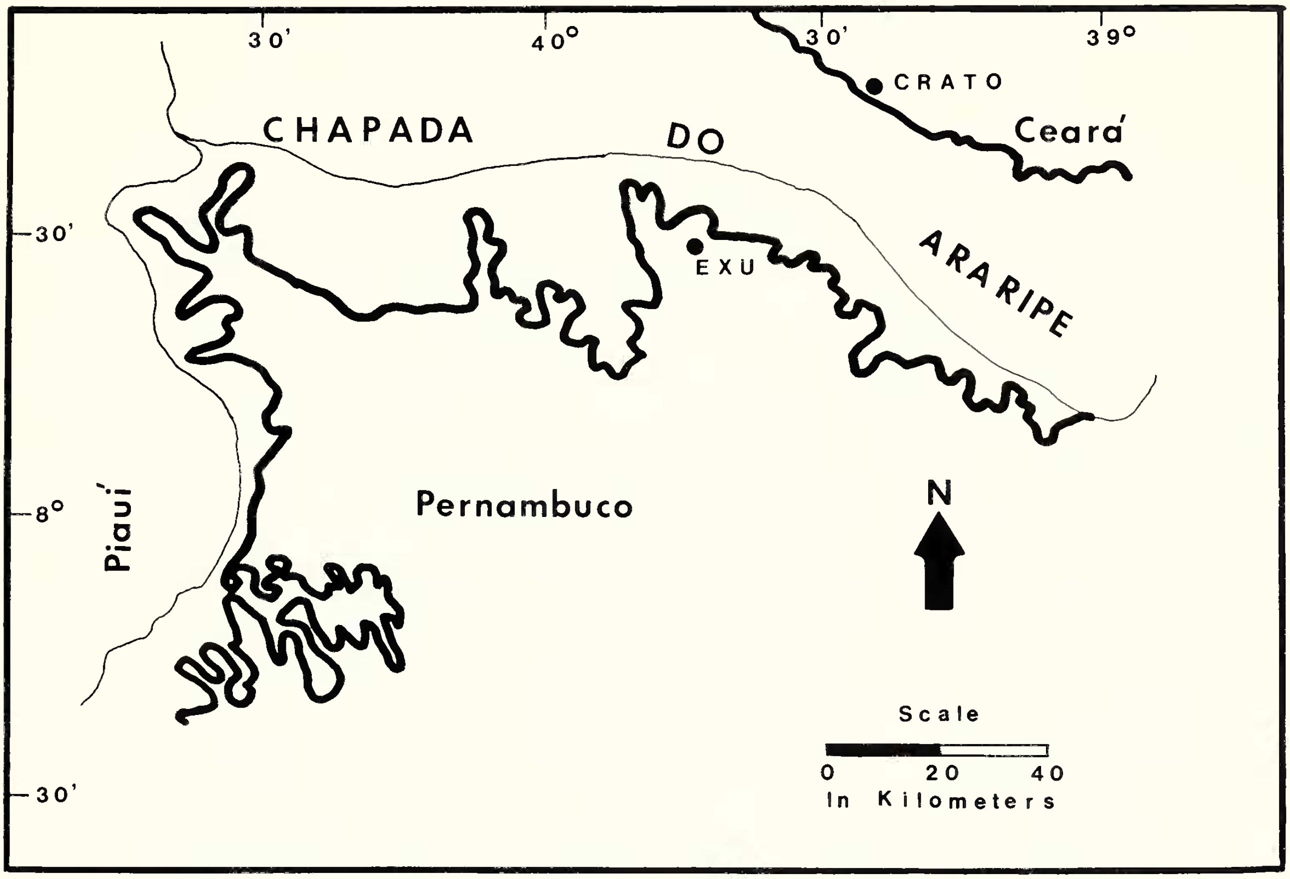

Fig. 3.—The Chapada do Araripe, a large sandstone plateau, dominates the landscape in the vicinity of both the Caatingas (Exu, Pernambuco) and Cerrado (Crato, Ceará) study sites. Caatingas study sites are located at least 10 to 15 km from the base of the Chapada. The Cerrado study area is located in the Floresta Nacional Araripe-Apodí on the top of the Chapada do Araripe, south of the city of Crato, Ceará. Heavy lines indicate the edge of the Chapada while thin lines indicate state boundaries (modified from Dias, 1960).

the non-volant mammal distribution patterns and a re-analysis of other vertebrate groups from the Caatingas (Mares et al., unpublished manuscript) indicates that the Caatingas was not an effective xeric refugium for mammals during more mesic times of the Pleistocene. Like the rainfall patterns that characterize the area, the Caatingas small-mammal fauna is anomalous, lacking the obvious physiological and morphological adaptations expected in a xeric environment.

STUDY SITES

My research was primarily restricted to the geographic center of the Caatingas in order to take advantage of the complete array of habitats available. Field work was equally divided between the municipality of Exu, Pernambuco, and the adjacent municipality of Crato, Ceará, in the Floresta Nacional Araripe-Apodí. The area is extremely complex; all three major geological formations characteristic of the Northeast are in close proximity with both Caatingas and Cerrado habitats represented. An extensive plateau, the Chapada do Araripe, dominates the landscape and extends for many miles along the border between Ceará and Pernambuco (Fig. 3). The Chapada has a pronounced effect on

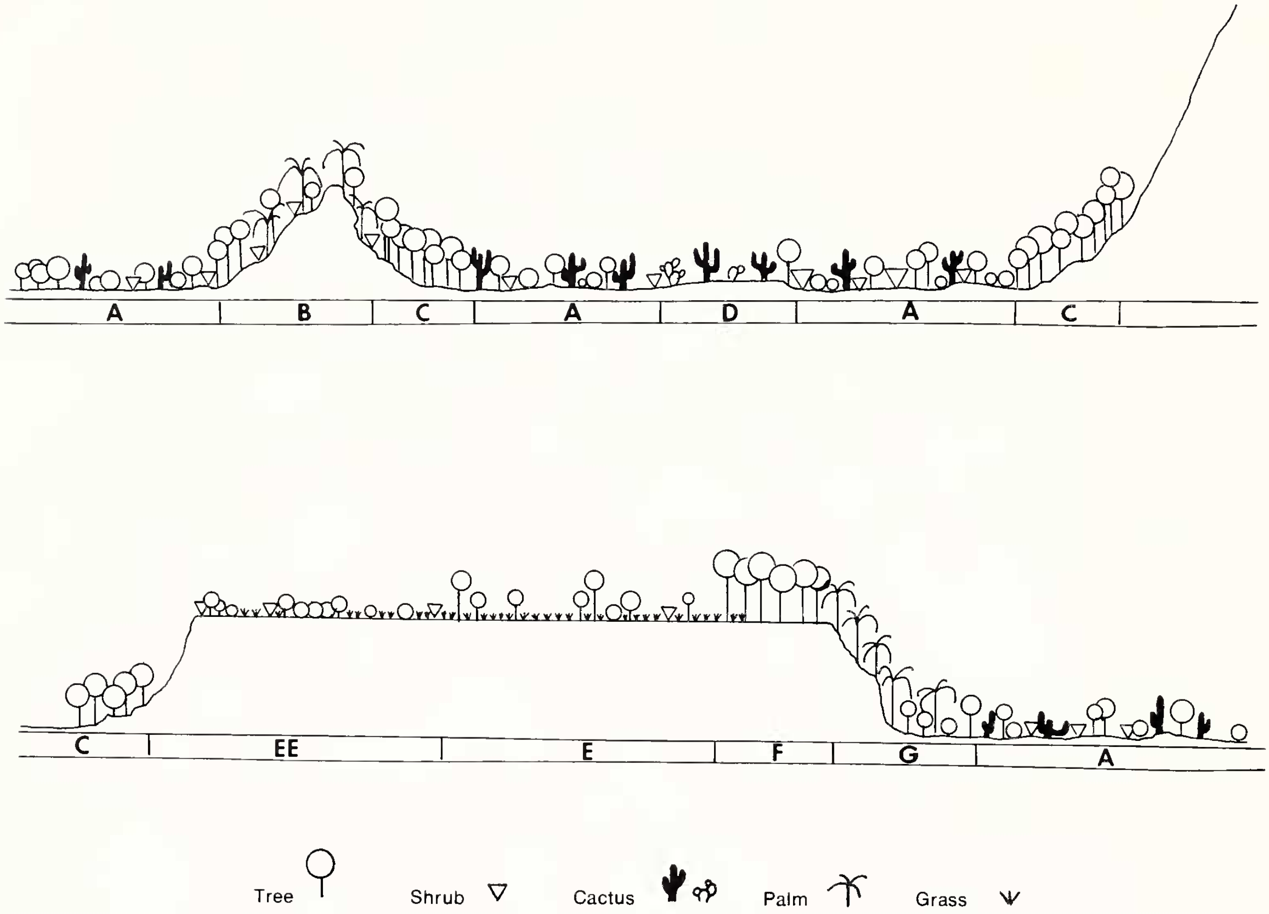

Fig. 4.—Schematic representation of the mosaic of habitats in the Caatingas and their proximity to Cerrado vegetation on the Chapada do Araripe and to humid forest in areas of orographic rainfall. Key to habitat types: A) Caatinga Baixa; B) Serrote; C) Caatinga Alta; D) Lajeiro; E) Cerrado; EE) disturbed areas; F) Cerradão; G) humid forest.

local rainfall patterns. On its windward side (Crato, Ceará), orographic precipitation produces conditions more conducive to mesic tropical vegetation, whereas on its leeward side (Exu, Pernambuco), xeric Caatingas vegetation predominates. The sandstone composition of the Chapada, in conjunction with elevated precipitation and lowered temperatures supports an edaphic form of Cerrado vegetation within the confines of the Caatingas proper. A schematic representation of the mosaic of habitats present in the Caatingas and their relationship to the Chapada do Araripe and Cerrado habitats is illustrated in Fig. 4.

THE CAATINGAS

In general, the Caatingas contains a variable assemblage of xeric-adapted plants. Much of the flora is characteristically deciduous during periods of water deficit, but members of the Cactaceae and Euphorbiaceae conspicuously exploit an alternate strategy of reduced leaf area and increased water storage capacity. The substantial xerophytic adaptations of the Caatingas flora, especially those exhibited by the Cactaceae and Euphorbiaceae demonstrate that this region has been subjected to xeric conditions for a substantial period of time (Alvim, 1949). Based upon vegetational physiognomy and local geology, four different Caatingas habitats may be distinguished—Caatinga Baixa (Low Caatinga), Caatinga Alta (High Caatinga), Serrotes, and Lajeiros (Fig. 5). Floral composition is often variable both within and between habitats; thus it is not the most effective criterion for defining habitat types.

Caatinga Baixa

Throughout lower elevations in the Exu region, Caatinga Baixa habitat predominates (Fig. 6). This is the most extensive habitat found in the region

Fig. 5.—Panoramic view of Caatingas habitats illustrating serrotes (in the background) with Caatinga Alta vegetation present on the slopes. The foreground contains fields in various stages of ecological succession.

because it is associated with the ubiquitous non-granitic crystalline substrata in the Northeast. Plant species composition differs greatly between localities; however, the vegetation is quite dense and many of the most common plants are shared between sites (see Mares et al., 1981). Trees are xerophytic and may reach a height of 3 to 5 m while occasional emergents may attain a height of 8 m. Large cacti such as *Cereus jamacaru* (Mandacaru), *Cephalocereus gounellei* (Xique-xique), and *Zehntherella squamulosa* (Facheiro) are common components, especially visible during dry periods. Minor differences in topography, variation in soil parameters, prior utilization by man, and differential exploita-

Fig. 6.—A locality in Exu, Pernambuco, containing a Lajeiro in the foreground with typical Caatinga Baixa vegetation in the background.

tion by domestic animals generate microhabitat mosaics which defy categorization using only a few broad generalizations.

Caatinga Alta

Larger xerophytic trees (10–12 m) characterize Caatinga Alta (see Mares et al., 1981). They typically lose their leaves in synchrony during the dry season and form a closed canopy in the wet season. The understory is poorly developed and density is lower than in Caatinga Baixa habitats. Caatinga Alta habitats are restricted to higher elevations, hillsides, and the perimeters of gentle valleys formed by serrotes and serras; these habitats are, therefore, more mesic than the surrounding Low Caatinga sites (Fig. 5). Small rock outcroppings or rock piles are dispersed throughout the forest floor, but rarely reach sizes greater than 25 m^2.

Lajeiros

Lajeiros are granitic rock outcroppings, principally distributed throughout areas dominated by Caatinga Baixa (Fig. 6). They are variable in both size and shape although they usually do not exceed a height of 15 m. In their simplest form, lajeiros may be small unbroken rock faces but at the other extreme, their area would best be measured in hectares. These expansive formations may be composed of rock faces containing many fissures studded with cacti and strewn with boulders of variable size and shape. *Pilosocereus gounelli, Cereus jamacaru,* and *Opuntia palmadora* (Palma) are the cacti most frequently associated with these outcroppings. Complex lajeiros appreciably magnify topographic complexity in the Caatingas (Mares et al., 1981); they appear to offer mesic refugia for many species of non-volant mammals (Lacher, 1981; Streilein, 1981) and thus are important habitats influencing mammal distribution patterns.

Serrotes

Numerous granitic serrotes are found in the municipality of Exu (see Figs. 3, 4 and 5). These mountain ridges harbor the most mesic components of the Caatingas flora and remain green for extended periods during the dry season. These areas, termed "brejos" by Andrade and Lins (1964), contain floral affinities with the Atlantic Rainforest vegetation and are important mesic refugia for both plants and animals in the Caatingas. Localities of increased orographic rainfall, like serrotes, are common throughout the Caatingas; the state of Pernambuco alone contains 22 major brejos (Andrade and Lins, 1964). Palms such as *Syargus oleracea* and *Accrocomia intumescens* are typically restricted to serrotes having increased orographic rainfall. Because the upper limits of Caatinga Alta also occur on the slopes of serrotes, there are places where substantial intermingling of their constituent vegetation occurs.

Fig. 7.—A typical locality on the Chapada do Araripe (Crato, Ceará) exhibiting three of the characteristic components of Cerrado habitats—pervasive grass species, small shrubs, and gnarled trees.

THE CHAPADA DO ARARIPE

The Floresta Nacional Araripe-Apodí contains most of the collection sites examined on the Chapada do Araripe. The plateau is characterized by a thin layer of sandy red soil covering a hard sandstone substrate. Rocks, boulders, and stones are absent from the Chapada as are permanent bodies of water. During the rainy season, low lying depressions may be covered with temporary pools con-

Fig. 8.—A road cutting through Cerradão vegetation at the edge of the Chapada do Araripe (Crato, Ceará). Large trees and a closed canopy distinguish this habitat from Cerrado.

taining from 6 to 12 inches of water. In general, the vegetation is sclerophyllous and semideciduous. Trees and shrubs lose their leaves each year, but leaf loss is asynchronous both intra- and interspecifically. Based upon physiognomy and density, two kinds of habitats are recognizable on the Chapada—Cerrado and Cerradão. Their relationship to each other and Caatingas vegetation is shown in Fig. 4.

Cerrado

Physiognomically, the Cerrado on the Chapada do Araripe is an open tree and shrub woodland with a pervasive grass component (Fig. 7). Small trees (3–5 m) and shrubs (0.5–3 m) form approximately half of the vegetation cover, and various grass species occupy the remaining area. Taller trees, rarely exceeding a height of 15 m are scattered throughout the area. As a result, the canopy is open, irregular and undulating in profile, with numerous areas lacking woody plants. The taller trees and shrubs have characteristically gnarled trunks and twisted branches; root penetration into the sandstone bedrock is minimal. The most common trees, shrubs, and grasses are listed in Mares et al. (1981).

Cerradão

Sections of the Floresta Nacional Araripe-Apodí, for the most part bordering the windward side of the Chapada do Araripe, differ substantially from Cerrado vegetation in plant density, physiognomy, and species importance. Stands with very little grass, few shrubs, and numerous trees are herein referred to as Cerradão (Fig. 8). Larger trees compose Cerradão habitats and form a closed canopy between 12 and 17 m high. These trees do not have the gnarled appearance characteristic of the Cerrado. The understory may vary from quite dense to sparse; however, in either situation, small shrubs (~1 m) and grasses are rare.

MATERIALS AND METHODS

FAUNAL COMPOSITION

Bats were collected by netting from September 1976 to May 1978 in Caatingas (Municipality of Exu, Pernambuco) and Cerrado (Chapada do Araripe, Municipality of Crato, Ceará) habitats in northeastern Brazil. I was interested in determining the composition of one community within the Caatingas and another within the Cerrado, so only monthly samples from within a restricted area were utilized in subsequent analyses. Sampling locales were contained within a circular area whose radius was 10 km in both biomes, and five to ten locales within that area were

Table 1.—*Description of external and cranial characters measured on specimens of bats captured in Exu, Pernambuco (Caatingas), and Crato, Ceará (Cerrado).*

External Characters

Total length: greatest distance from the anteriormost portion of the snout to the distal point of the tail.
Tail length: greatest distance from the distal caudal vertebra to the angle made by the tail when positioned perpendicular to the body.
Hind foot length: distance from the heel of the foot to the tip of the longest toe including the claw.
Ear length: distance from the basal notch of the ear to the furthermost point on the edge of the pinna.
Tragus length: distance from the base of the tragus to its distal edge.
Forearm length: distance from the outside of the wrist to the outside of the elbow when the wing is folded.
Weight: weight of the fresh specimen.
Length of digit one: length from the wrist to the distalmost point of the first digit, including the claw.
Length of digit three: length from the wrist to the distal point on the phalange of digit three when the wing is maximally extended.
Length of digit four: length from the wrist to the distal point on the phalange of digit four when the wing is maximally extended.
Length of digit five: length from the wrist to the distal point on the phalange of digit five when the wing is maximally extended.
Tibia length: length from the outermost point of the ankle to the outermost point of the knee.
Calcar length: length from the distal point of the calcar to the angle made by the calcar when it is positioned perpendicular to the leg.
Noseleaf length: length from the distalmost point of the noseleaf to its juncture with the rostrum.

Cranial Characters

Greatest length of skull: distance from the most anterior part of the rostrum (excluding teeth) to the posteriormost point of the skull.
Condylobasal length: distance from the anteriormost edge of the premaxillae to the posteriormost projection of the occipital condyles.
Zygomatic breadth: greatest distance between the outer margins of the zygomatic arches.
Postorbital constriction: least distance across the top of the skull posterior to the postorbital process.
Mastoid breadth: greatest width of the skull, including the mastoid.
Breadth of the braincase: greatest width across the braincase posterior to the zygomatic arches.
Rostral breadth: width of the rostrum at the suture between premaxillae and maxillae.
Height of the braincase: greatest height of the braincase from a line perpendicular to the long axis of the skull (+1 mm).
Breadth across the upper molars: maximum width from the outer alveolus of one molar to the outer alveolus of another.
Breadth across the upper canines: width from the outer alveolus of one canine to the outer alveolus of the other canine.
Length of maxillary tooth row: length from the anterior edge of the alveolus of the first tooth present in the maxillae to the posterior edge of the alveolus of the last molar.

Table 1.—*Continued.*

Length of the upper molariform toothrow: maximum length from the anterior edge of the alveolus of the first cheek tooth to the posterior edge of the alveolus of the last molar.
Width of widest molar: width of widest molar in the maxilla exlcuding the alveolus.
Greatest length of the mandible: length from the anteriormost point on the ramus (excluding teeth) to the posteriormost point on the coronoid process.
Length of mandibular tooth row: length from the anterior edge of the alveolus of the canine to the posterior edge of the alveolus of the last molar in the mandible.
Length of coronoid process: distance from the posteriormost point on the coronoid process to the base of the ramus.

visited each month. Standard Japanese mist nets (10 m by 2 m) were used to collect specimens. Although the position of the nets was determined by peculiarities of the terrain and the physiognomy of the vegetation, I was usually able to erect 10 sections of netting per night in the most frequented collection sites. All nets were positioned before dusk and checked at 15-min intervals or sooner depending upon the level of bat activity. Because activity usually was quite high at most collection sites, the nets were, in effect, monitored continuously. Nets remained open for a minimum of 3.5 to 4 h each night. Initial field work indicated that additional netting was counter-productive; total activity diminished drastically after 2100–2130 hours and the same species caught earlier in the night were caught during later time periods. Supplemental collecting from roosts (for example, caves, tree hollows, buildings, culverts, etc.) was also done in order to verify that the faunal composition was not biased by collecting techniques. Half of the collection is housed in the Carnegie Museum of Natural History; the other half is deposited in the Museu de Zoologia da Universidade de São Paulo in Brazil.

Individual, Secondary Sexual, and Geographic Variation

When collections were sufficiently large, 14 external characteristics and 16 cranial characteristics were determined for a sample of 20 adult males and 20 adult females from both Caatingas and Cerrado habitats. Otherwise the entire collection from each biome was used in subsequent analyses. Table 1 lists and describes all of the characters used throughout the statistical analyses. External characters were measured to the nearest millimeter utilizing a metric ruler; cranial characters were measured with metric dial calipers to the nearest hundredth of a millimeter.

Individual variation was determined for males and females within both Caatingas and Cerrado communities. The standard deviation (SD) and coefficient of variation were utilized as statistical estimates of individual variation for each mensural character.

Two-way analysis of variance was utilized to ascertain the existence of geographic and secondary sexual variation in species with sufficiently large samples of males and females from both Caatingas and Cerrado biomes. When samples were small for one or both biomes, the data were combined and secondary sexual variation was examined utilizing one-way analysis of variance; this technique also was utilized for species found only in one biome. Levene's test for homogeneity of variance was performed on all variables in order to determine the appropriateness of the analysis of variance.

Sexual dimorphism for *size* is indicated when a particular sex consistently has larger sample means than the opposite sex and many of those characters exhibit statistically significant sexual variation. If the actual differences between population mean values is small, large samples are required to detect statistical significance between sample means; in such cases where samples are small the consistent observation of larger mean values for a particular sex suggests sexual dimorphism for size but is inconclusive until larger samples can be obtained. Sexual dimorphism for shape occurs when many characters exhibit statistically significant secondary sexual variation but obvious trends for mean value relations do not exist.

RESULTS AND DISCUSSION

Faunal Composition

Over 5,000 bat specimens representing 38 species, 29 genera, and eight families were captured during this study; 65% of the mammalian species known from the Exu-Crato area are members of the Chiroptera. Table 2 lists the bat species from this study in systematic order, indicates their relative abundance in Caatingas or Cerrado biomes, and identifies their feeding guild associations. Twenty species are shared between biomes; further, the Caatingas contains 13 species not found in the Cerrado, whereas the Cerrado contains five species not found in the Caatingas. If only the non-rare species in each biome are considered, the dissimilarities between areas become more pronounced—15 of the 24 species (over half of the species pool) occur exclusively in one or the other of the areas. Despite their geographic proximity, the Caatingas and Cerrado habitats contain markedly different bat faunas.

Contrary to my earlier prediction, the Caatingas community is more species rich than the Cerrado community. A more detailed examination of the distribution of bats within each community suggests an explanation for this observation. Faunal composition and species densities are rather uniform throughout Cerrado habitats on the Chapada do Araripe. Conversely, the Caatingas is quite heterogeneous in this regard. Caatinga Baixa contains few species of bats, and those species present occur at low densities. Lajeiros contain a few additional species (*Neoplatymops mattogrossensis* and *Peropteryx macrotis*), but in general, the fauna of the Caatingas in low-lying areas (Caatinga Baixa and lajeiros) is depauperate. Species of foliage gleaning insectivore (*Mimon crenulatum, Micronycteris megalotis, Micronycteris minuta*, and *Tonatia brasiliense*) reach their highest density and occur almost exclusively in Caatinga Alta. With few exceptions, however, serrotes harbor the bulk of the species found in the Caatingas and it is on serrotes or the adjacent areas of Caatinga Alta that most species reach their highest densities. Thus, the relatively high species richness of the Caatingas can be attributed in part to the topographic relief and vegetational diversity of the Caatingas, but equally important from the point of view of the Chiroptera, the numerous serrotes punctuating the flat landscape of the Caatingas provide roosting sites and mesic refugia during drought periods.

Frugivore guilds in the Caatingas and Cerrado are quite similar in terms of species richness and taxonomic composition. The main distinction among the guilds is the greater density of all frugivorous species on the Chapada and the presence there of an additional small species, *A. concolor*. The presence of *L. mordax* in the Caatingas is the most obvious difference between the biomes with respect to nectarivores. Neither frugivores nor nectarivores appreciably affect the faunal differences between the Caatingas and Cerrado.

The notable absence of sanguinivores and piscivores from among the common Cerrado bats diminishes the diversity of that fauna. Large native mammals are absent from the Chapada and domestic species are prohibited by law from entering the Floresta Nacional Araripe-Apodí. Thus, it is not surprising to find vampires rare in Chapada habitats. The absence of standing bodies of water from the Chapada accounts for the rareness of piscivores.

The disparity between the Caatingas and Cerrado bat faunas is most clearly manifested within the various insectivore guilds. The Caatingas harbors a diverse insectivore fauna; five species of foliage gleaning insectivores, two species of aerial insectivores, and two species of molossid insectivores reach appreciable densities there. In contrast, *M. nigricans, E. furinalis*, and *M. molossus* are the only insectivorous bats that attain appreciable densities

Table 2.—*Systematic listing of bats from Caatingas (Exu, Pernambuco) and Cerrado (Crato, Ceará) biomes; A indicates abundant, C indicates common, R indicates rare, and—indicates absent. Feeding guild abbreviations: AERIN, aerial insectivore; PISCI, piscivore; FOLGL, foliage-gleaning insectivore; OMNIV, omnivore; NECTA, nectarivore; FRUGI, frugivore; SANGU, sanguinivore; MOLOS, molossid aerial insectivore.*

	Species	Presence		Guild
		Caatingas	Cerrado	
Family	Emballonuridae			
	Saccopteryx leptura	—	R	AERIN
	Peropteryx macrotis	C	—	AERIN
Family	Noctilionidae			
	Noctilio leporinus	C	R	PISCI
Family	Mormoopidae			
	Pteronotus davyi	R	R	AERIN
Family	Phyllostomidae			
Subfamily	Phyllostominae			
	Micronycteris megalotis	R-C	R	FOLGL
	Micronycteris minuta	R-C	R	FOLGL
	Tonatia bidens	R	—	FOLGL
	Tonatia brasiliense	R-C	—	FOLGL
	Tonatia silvicola	C	—	FOLGL
	Mimon crenulatum	R-C	—	FOLGL
	Phyllostomus discolor	R-C	A	OMNIV
	Phyllostomus hastatus	R	A	OMNIV
	Trachops cirrhosus	C	—	OMNIV
Subfamily	Glossophaginae			
	Glossophaga soricina	A	A	NECTA
	Lonchophylla mordax	C	—	NECTA
	Anoura geoffroyi	R	C	NECTA
Subfamily	Carolliinae			
	Carollia perspicillata	A	A	FRUGI
Subfamily	Stenodermatinae			
	Sturnira lilium	R	C-R	FRUGI
	Uroderma magnirostrum	R	R	FRUGI
	Vampyrops lineatus	A	A	FRUGI
	Artibeus concolor	—	C-R	FRUGI
	Artibeus jamaicensis	C	A	FRUGI
	Artibeus lituratus	C-R	A	FRUGI
Subfamily	Desmodontinae			
	Desmodus rotundus	A	R	SANGU
	Diphylla ecaudata	R	—	SANGU
Family	Natalidae			
	Natalus stramineus	—	R	AERIN
Family	Furipteridae			
	Furipterus horrens	R	—	AERIN
Family	Vespertilionidae			
	Myotis nigricans	C-A	C	AERIN
	Eptesicus furinalis	—	C-R	AERIN
	Lasiurus borealis	—	R	AERIN
	Lasiurus ega	R	R	AERIN
Family	Molossidae			
	Molossops planirostris	R	—	MOLOS
	Molossops temminckii	R	R	MOLOS
	Tadarida laticaudata	R	R	MOLOS
	Neoplatymops mattogrossensis	C	—	MOLOS
	Molossus ater	R	—	MOLOS
	Molossus molossus	A	A	MOLOS
	Eumops sp.	R	—	MOLOS

on the Chapada do Araripe, and their presence is primarily restricted to disturbed areas containing abandoned buildings. None of the common Cerrado insectivores glean their prey from foliage. The savanna-like characteristics of the Chapada (that is, open spaces, low canopy, reduced vertical stratification within the canopy) as well as the depauperate nature of the Cerrado insect fauna limit the potential number of insectivore niches available for bats to exploit and to a large extent accounts for the depauperate nature of the Cerrado bat fauna in general.

SPECIES ACCOUNTS

Family Emballonuridae

Saccopteryx leptura Schreber, 1774

This aerial insectivore was absent from the Caatingas and was quite rare on the Chapada do Araripe. Further, the specific designation of *S. bilineata* was applied to both specimens of *S. leptura* from the Chapada do Araripe by Mares et al. (1981). Very little is known about the biology of *S. leptura* and only isolated records of mensural characters appear in the literature. Statistical analyses could not be performed on the sample of two individuals obtained from the Chapada do Araripe; hence only selected individual measurements (after Swanepoel and Genoways, 1979) are reported here for an adult female and an adult male (total length, 61, 69; tail length, 17, 14; hindfoot length, 6, 6; ear length, 13, 13; greatest length of skull,—, 13.3; condylobasal length, —, 121; zygomatic breadth, —, —; postorbital constriction, 2.3, 2.3; breadth of braincase, 6.8, 6.9; length of the maxillary toothrow, 5.4, —; breadth across the upper molars, 6.2, —).

Peropteryx macrotis (Wagner, 1843)

Of the three subspecies presently recognized, only *P. m. macrotis* occurs on the mainland of South America (Cabrera, 1957). Although uncommon in the Caatingas, this aerial insectivore was found roosting in small aggregations of up to 10 individuals in large openings inside rockpiles or culverts. Over a 6 month period, the number of individuals in each of two monitored roosting sites remained constant. Further, each roost contained only one adult male. This suggests that *P. m. macrotis* males might maintain small harems and exhibit resource defense polygony when appropriate roosting conditions are available. Distances between neighboring individuals in the roost varied from 15 to 60 cm. Individuals roosted by anchoring their feet and thumbs to the ceiling of the retreat site; hence, their bodies assumed an acute angle with respect to the overlying rock stratum. These bats were frequently observed leaving their roosts before dusk. The absence of *P. m. macrotis* from the Chapada do Araripe can most easily be explained by the lack of suitable roosting sites.

The results of the statistical analyses of 13 external and 16 cranial characters on specimens from the Chapada do Araripe are summarized in Table 3. Sample means for females are larger than sample means for males for 10 external characters and 15 cranial characters; statistically significant differences exist for total length, tragus length, forearm length, length of digit III, length of digit V, condylobasal length, breadth across the upper molars, breadth across the upper canines, and greatest length of the maxillary. The sample means for males are larger than those for females for three external and one cranial character; none exhibit statistically significant differences. Sexual dimorphism with females larger than males is clearly supported by the data.

Family Noctilionidae

Noctilio leporinus (Linnaeus, 1758)

Of the three subspecies of this piscivore currently recognized, *Noctilio l. leporinus* is the appropriate designation for specimens from the Northeast of Brazil (Davis, 1973). It was exceptionally rare on the Chapada do Araripe; the few individuals caught there were probably transients from surrounding habitats. It was common in the Caatingas where it roosted during the day in groups of up to 30 individuals. The large hollow hardwood trees typically found in Caatinga Alta habitats provided its preferred diurnal roosting sites. Sex ratios did not significantly differ from one to one based upon overall netting records or data from individual day roosts (Binomial Test, $P > .05$). Approximately 47% of the 328 captured adult specimens from the Caatingas were males.

Individuals frequently foraged at small lakes and ponds in groups containing five to 15 bats. Individuals seemed to coordinate feeding activities and concentrated foraging activity on the periphery of bodies of water. A concrete bridge which traversed a semipermanent stream contained a nocturnal feeding roost that was used by over 150 individuals. This roost was in continual use for the duration of

Table 3.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, N) of* Peropteryx macrotis *males and females from the Caatinga biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	61.33	64.14			Sex	1	37.673	5.30	.032
SD	1.99	3.81			Within	20	7.110		
SE	.51	1.44							
CV	3.24	5.94							
n	15	7							
Tail length									
Mean	14.20	14.14			Sex	1	.016	.00	.945
SD	1.61	2.12			Within	20	3.163		
SE	.42	.80							
CV	11.34	14.99							
n	15	7							
Hindfoot length									
Mean	6.60	6.57			Sex	1	.004	.01	.919
SD	.51	.79			Within	20	.366		
SE	.13	.30							
CV	7.73	12.02							
n	15	7							
Ear length									
Mean	14.20	14.43			Sex	1	.249	.49	.491
SD	.56	.98			Within	20	.506		
SE	.15	.37							
CV	3.94	6.79							
n	15	7							
Tragus length									
Mean	6.13	6.71			Sex	1	1.611	6.25	.021
SD	.52	.49			Within	20	.258		
SE	.13	.18							
CV	8.48	7.30							
n	15	7							
Forearm length									
Mean	42.00	43.57			Sex	1	11.786	13.31	.002
SD	.85	1.13			Within	20	.886		
SE	.22	.43							
CV	2.02	2.59							
n	15	7							
Weight									
Mean	4.23	4.57			Sex	1	.546	1.08	.312
SD	.59	.93			Within	20	.507		
SE	.15	.35							
CV	13.95	20.35							
n	15	7							
Length of digit one									
Mean	7.53	7.14			Sex	1	.728	1.00	.330
SD	.74	1.07			Within	20	.730		
SE	.19	.40							
CV	9.83	14.99							
n	15	7							

Table 3.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	64.67	68.00			Sex	1	53.03	5.91	.025
SD	2.38	4.08			Within	20	8.97		
SE	62	1.54							
CV	3.68	6.00							
n	15	7							
Length of digit four									
Mean	45.80	47.43			Sex	1	12.658	3.01	.098
SD	1.37	3.10			Within	20	4.206		
SE	.36	1.17							
CV	2.99	6.54							
n	15	7							
Length of digit five									
Mean	44.40	46.86			Sex	1	28.82	12.41	.002
SD	1.35	1.86			Within	20	2.32		
SE	.35	.71							
CV	3.04	3.97							
n	15	7							
Tibia length									
Mean	18.80	19.14			Sex	1	.561	1.21	.284
SD	.56	.90			Within	20	.463		
SE	.15	.34							
CV	2.98	4.70							
n	15	7							
Calcar length									
Mean	15.80	16.14			Sex	1	.561	.34	.568
SD	1.27	1.35			Within	20	1.660		
SE	.33	.51							
CV	8.04	8.36							
n	15	7							
Greatest length of skull									
Mean	13.75	13.99			Sex	1	.258	3.67	.070
SD	.30	.17			Within	20	.070		
SE	.08	.06							
CV	2.18	1.22							
n	15	7							
Condylobasal length									
Mean	12.74	13.03			Sex	1	.397	5.00	.037
SD	.25	.35			Within	20	.080		
SE	.06	.13							
CV	1.96	2.69							
n	15	7							
Zygomatic breadth									
Mean	8.15	8.31			Sex	1	.134	3.91	.480
SD	.16	.23			Within	20	.034		
SE	.04	.09							
CV	1.96	2.77							
n	15	7							

Table 3.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	2.47	2.50			Sex	1	.003	.15	.702
SD	.15	.14			Within	20	.023		
SE	.04	.05							
CV	6.07	5.60							
n	15	7							
Mastoid breadth									
Mean	7.25	7.27			Sex	1	.003	.08	.786
SD	.13	.30			Within	20	.039		
SE	.03	.12							
CV	1.79	4.13							
n	15	7							
Breadth of braincase									
Mean	6.49	6.49			Sex	1	.000	.00	.989
SD	.16	.09			Within	20	.020		
SE	.04	.03							
CV	2.47	1.39							
n	15	7							
Rostral breadth									
Mean	5.97	6.15			Sex	1	.134	2.45	.135
SD	.23	.24			Within	18	.055		
SE	.06	.10							
CV	3.85	3.90							
n	14	6							
Height of braincase									
Mean	7.45	7.50			Sex	1	.009	.16	.692
SD	.26	.18			Within	19	.058		
SE	.07	.07							
CV	3.49	2.40							
n	15	6							
Breadth across the upper molars									
Mean	6.02	6.48			Sex	1	.896	13.53	.002
SD	.21	.35			Within	18	.066		
SE	.06	.14							
CV	3.49	5.40							
n	14	6							
Breadth across the upper canines									
Mean	3.47	3.67			Sex	1	.160	6.52	.020
SD	.14	.19			Within	18	.025		
SE	.04	.08							
CV	4.03	5.18							
n	14	6							
Length of the maxillary toothrow									
Mean	5.49	5.53			Sex	1	.007	.16	.695
SD	.18	.27			Within	19	.043		
SE	.05	.11							
CV	3.28	4.88							
n	15	6							
Length of the upper molariform toothrow									
Mean	4.01	4.10			Sex	1	.032	1.40	.252
SD	.16	.14			Within	19	.023		
SE	.04	.06							
CV	3.99	3.41							
n	15	6							

Table 3.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Width of the widest molar									
Mean	1.73	1.78			Sex	1	.011	2.49	.131
SD	.06	.08			Within	19	.004		
SE	.02	.03							
CV	3.47	4.49							
n	15	6							
Greatest length of the mandible									
Mean	9.51	9.91			Sex	1	.747	8.03	.011
SD	.27	.37			Within	19	.093		
SE	.07	.14							
CV	2.84	3.73							
n	14	7							
Length of the mandibular toothrow									
Mean	5.64	5.77			Sex	1	.077	1.61	.219
SD	.17	.29			Within	19	.048		
SE	.05	.11							
CV	3.01	5.03							
n	14	7							
Length of the coronoid process									
Mean	2.47	2.63			Sex	1	.104	2.89	.109
SD	.19	.20			Within	16	.036		
SE	.06	.08							
CV	7.69	7.60							
n	11	7							

the study and had probably been used previously for an extended period (based upon the quantity of accumulated feces).

The Caatingas collection represents the largest analyzed sample of *Noctilio leporinus* from a single freely interbreeding population (see Davis, 1973). The results of a statistical analysis of 20 mensural morphological characters in *N. l. leporinus* are summarized in Table 4. Like the results reported by Davis (1973) for specimens from the Pacific versant of Chiapas, Mexico (*N. l. mastivus*), males tend to be more variable than females with consistently larger coefficients of variation. The sample means for males are larger than sample means for females for all 13 external characters analyzed, with statistically significant differences found for 10 of the variables. Males are statistically significantly different than, and larger on the average than, females for 15 of the 16 cranial characters. Although the sample mean for females is larger than that of males for the single character width of the widest molar, the difference is not statistically significant. *Noctilio l. leporinus* exhibits extreme sexual dimorphism with males consistently larger on the average than females.

Davis (1973) reported morphometric data from three localities (Upper Amazon Basin, Lower Amazon Basin, and the Guianas) within the range of *N. l. leporinus*. This facilitates comparison with the Caatingas population which is the northeastern-most collection locale of the species for which extensive morphometric data are available. The Caatingas population has larger mean values for four of the five morphometric characters reported by Davis (1973) and as such represents the most robust population within the subspecies. Further, among populations of *N. l. leporinus*, the Caatingas specimens are morphometrically more similar to specimens from the Upper Amazon Basin than to other populations.

Family Mormoopidae

Pteronotus davyi Gray, 1838

This aerial insectivore was rare in both Caatingas and Cerrado biomes. Of the three subspecies currently recognized, *P.d. davyi* is the appellation appropriate for specimens from the Northeast of Brazil (Smith, 1972).

Smith (1972) presented an analysis of systematic

Table 4.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Noctilio leporinus *males and females from both Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant (P< .050) secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	123.35	116.50	120.00	116.75	Sex	1	495.114	27.46	<.001
SD	3.84	4.57	—	5.38	Within	43	18.027		
SE	.86	1.02	—	2.69					
CV	3.11	3.92	—	4.61					
n	20	20	1	4					
Tail length									
Mean	27.60	25.30	28.00	25.75	Sex	1	56.400	11.52	.002
SD	2.54	2.06	—	1.50	Within	43	4.857		
SE	.57	.46	—	.75					
CV	9.20	8.14	—	5.83					
n	20	20	1	4					
Hindfoot length									
Mean	28.60	27.25	30.00	27.00	Sex	1	23.819	15.85	<.001
SD	1.27	1.16	—	1.41	Within	43	1.503		
SE	.29	.26	—	.71					
CV	4.44	4.26	—	5.22					
n	20	20	1	4					
Ear length									
Mean	28.45	28.55	28.00	27.50	Sex	1	.032	.02	.888
SD	1.57	.95	—	.58	Within	43	1.599		
SE	.35	.21	—	.29					
CV	5.52	3.33	—	2.11					
n	20	20	1	4					
Tragus length									
Mean	8.25	8.10	8.00	7.50	Sex	1	.635	1.98	.167
SD	.55	.55	—	.58	Within	43	.321		
SE	.12	.12	—	.29					
CV	6.67	6.79	—	7.73					
n	20	20	1	4					
Forearm length									
Mean	85.70	84.85	84.00	84.75	Sex	1	6.914	1.71	.199
SD	1.98	2.11	—	2.06	Within	43	4.053		
SE	.44	.47	—	1.03					
CV	2.31	2.49	—	2.43					
n	20	20	1	4					
Weight									
Mean	69.20	61.33	61.50	55.88	Sex	1	793.411	11.35	.002
SD	11.45	4.07	—	3.75	Within	43	69.895		
SE	2.56	.91	—	1.88					
CV	16.55	6.64	—	6.71					
n	20	20	1	4					
Length of digit one									
Mean	13.45	12.35	13.00	12.75	Sex	1	11.468	15.92	<.001
SD	1.00	.75	—	.50	Within	43	.720		
SE	.22	.17	—	.25					
CV	7.43	6.07	—	3.92					
n	20	20	1	4					

Table 4.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	169.35	164.75	167.00	166.00	Sex	1	205.143	10.13	.003
SD	4.57	4.67	—	4.08	Within	43	20.250		
SE	1.02	1.04	—	2.04					
CV	2.70	2.83	—	2.46					
n	20	20	1	4					
Length of digit four									
Mean	127.11	123.05	124.00	124.25	Sex	1	153.525	10.76	.002
SD	3.93	3.86	—	2.75	Within	43	14.266		
SE	.88	.86	—	1.38					
CV	3.09	3.14	—	2.21					
n	20	20	1	4					
Length of digit five									
Mean	100.70	98.05	100.00	96.75	Sex	1	89.911	11.11	.002
SD	3.13	2.69	—	2.50	Within	43	8.093		
SE	.70	.60	—	1.25					
CV	3.11	2.74	—	2.58					
n	20	20	1	4					
Tibia length									
Mean	41.55	39.80	41.00	40.00	Sex	1	32.006	17.52	<.001
SD	1.36	1.40	—	1.41	Within	43	1.827		
SE	.30	.31	—	.71					
CV	3.27	3.52	—	3.53					
n	20	20	1	4					
Calcar length									
Mean	42.85	41.30	43.00	40.00	Sex	1	35.240	11.99	.001
SD	1.95	1.56	—	.82	Within	43	2.940		
SE	.44	.35	—	.41					
CV	4.55	3.78	—	2.05					
n	20	20	1	4					
Greatest length of skull									
Mean	26.77	24.93	24.50	24.43	Sex	1	36.745	69.69	<.001
SD	.81	.47	—	.34	Within	43	.527		
SE	.18	.11	—	.17					
CV	3.03	1.89	—	1.39					
n	20	20	1	4					
Condylobasal length									
Mean	24.33	23.16	23.60	23.23	Sex	1	14.265	103.22	<.001
SD	.43	.30	—	.29	Within	43	.138		
SE	.10	.07	—	.14					
CV	1.77	1.30	—	1.25					
n	20	20	1	4					
Zygomatic breadth									
Mean	19.63	18.70	19.70	18.60	Sex	1	10.007	58.18	<.001
SD	.54	.31	—	.16	Within	43	.172		
SE	.12	.07	—	.08					
CV	2.75	1.66	—	.86					
n	20	20	1	4					

Table 4.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Postorbital constriction					
Mean	6.98	6.75	7.00	6.73	Sex	1	.641	15.23	<.001
SD	.16	.22	—	.36	Within	43	.042		
SE	.04	.05	—	.18					
CV	2.29	3.26	—	5.35					
n	20	20	1	4					
				Mastoid breadth					
Mean	18.34	16.89	16.60	16.80	Sex	1	20.727	38.13	<.001
SD	.95	.38	—	.20	Within	43	.544		
SE	.21	.09	—	.12					
CV	5.18	2.25	—	1.19					
n	20	20	1	3					
				Breadth of braincase					
Mean	13.77	13.47	14.00	13.78	Sex	1	1.161	17.85	<.001
SD	.22	.29	—	.25	Within	43	.065		
SE	.05	.07	—	.13					
CV	1.60	2.15	—	1.81					
n	20	20	1	4					
				Rostral breadth					
Mean	9.96	9.57	9.90	9.50	Sex	1	1.776	33.61	<.001
SD	.25	.20	—	.34	Within	43	.053		
SE	.06	.04	—	.17					
CV	2.51	2.09	—	3.58					
n	20	20	1	4					
				Height of braincase					
Mean	15.83	14.91	15.30	15.20	Sex	1	8.013	14.37	<.001
SD	1.05	.33	—	.29	Within	43	.558		
SE	.24	.07	—	.15					
CV	6.63	2.21	—	1.91					
n	20	20	1	4					
				Breadth across the upper molars					
Mean	12.64	12.28	12.30	12.08	Sex	1	1.560	34.72	<.001
SD	.22	.19	—	.19	Within	43	.045		
SE	.05	.04	—	.10					
CV	1.74	1.55	—	1.57					
n	20	20	1	4					
				Breadth across the upper canines					
Mean	9.44	8.73	9.60	8.65	Sex	1	5.974	109.89	<.001
SD	.26	.22	—	.13	Within	43	.054		
SE	.06	.05	—	.07					
CV	2.75	2.52	—	1.50					
n	20	20	1	4					
				Length of the maxillary toothrow					
Mean	10.62	10.25	10.30	10.08	Sex	1	1.610	41.22	<.001
SD	.22	.17	—	.10	Within	43	.039		
SE	.05	.04	—	.05					
CV	2.07	1.66	—	.99					
n	20	20	1	4					
				Length of the upper molariform toothrow					
Mean	8.71	8.50	8.70	8.58	Sex	1	.435	13.13	<.001
SD	.22	.14	—	.22	Within	43	.033		
SE	.05	.03	—	.11					
CV	2.53	1.65	—	2.56					
n	20	20	1	4					

Table 4.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Width of the widest molar					
Mean	3.29	3.31	3.00	3.23	Sex	1	.004	.22	.642
SD	.16	.10	—	.17	Within	43	.020		
SE	.04	.02	—	.09					
CV	4.86	3.02	—	5.26					
n	20	20	1	4					
				Greatest length of the mandible					
Mean	19.28	18.39	18.70	18.55	Sex	1	7.822	37.77	<.001
SD	.42	.49	—	.45	Within	43	.207		
SE	.09	.11	—	.23					
CV	2.18	2.66	—	2.43					
n	20	20	1	4					
				Length of the mandibular toothrow					
Mean	11.63	11.13	11.30	11.10	Sex	1	2.629	80.58	<.001
SD	.19	.18	—	.08	Within	43	.033		
SE	.04	.04	—	.04					
CV	1.63	1.62	—	.72					
n	20	20	1	4					
				Length of the coronoid process					
Mean	7.10	6.41	6.70	6.45	Sex	1	5.005	66.86	<.001
SD	.33	.23	—	.10	Within	43	.075		
SE	.07	.05	—	.05					
CV	4.65	3.59	—	1.55					
n	20	20	1	4					

relations within the family Mormoopidae, and considered to some extent, individual, secondary sexual, and geographic variation in the various species within the family. He stated that secondary sexual variation is apparent in *P. davyi* but noted that the number of characters that do differ between the sexes is related to geographic area. Data are combined from Caatingas and Cerrado populations because the samples from each site are small. Although geographic differences between areas can no longer be detected, this compromise facilitates the detection of sexual dimorphism in *P. davyi.* The results of the statistical analyses are shown in Table 5. Statistically significant secondary sexual variation is evident in three external characters in which the males are larger on the average than the females (ear length, tragus length, length of digit I); statistically significant secondary sexual variation is detected in only one external character in which the females are larger on the average than the males. None of the cranial characters exhibits statistically significant secondary sexual variation and a pattern in mean values is not observed for either external or cranial characters.

Family Phyllostomidae

Subfamily Phyllostominae

Micronycteris megalotis (Gray, 1842)

Of the four subspecies currently recognized, *M. m. megalotis* is the designation applicable to populations in Northeast Brazil (Jones and Carter, 1976). Mares et al. (1981) erroneously listed specimens of this species as *M. minuta* in their preliminary assessment of mammals from the Northeast of Brazil. This foliage gleaning insectivore was rare in both Caatingas and Cerrado biomes.

Numerous authors have reported measurements from *M. megalotis* (see Swanepoel and Genoways, 1979); however, only Miller (1898), Lima (1926), Cunha Vieira (1942) and Taddei (1975*a*) included specimens from Brazil. Taddei (1975*a*) reported information on individual variation, but did not perform statistical analyses in order to detect sexual dimorphism. Because samples were small from both Caatingas and Cerrado habitats, the data are combined for subsequent statistical analyses. The results are summarized in Table 6. Among the external

Table 5.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Pteronotus davyi *males and females from both Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant (*P < .050*) secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	81.00		84.43	82.75	Sex	1	4.167	.42	.531
SD	—		2.44	4.19	Within	10	9.875		
SE	—		.92	2.10					
CV	—		2.89	5.06					
n	1		7	4					
Tail length									
Mean	23.00		24.00	22.75	Sex	1	3.375	1.32	.278
SD	—		1.29	2.22	Within	10	2.563		
SE	—		.49	1.11					
CV	—		5.38	9.76					
n	1		7	4					
Hindfoot length									
Mean	9.00		9.43	9.25	Sex	1	.042	.16	.699
SD	—		.54	.50	Within	10	.263		
SE	—		.20	.25					
CV	—		5.73	5.41					
n	1		7	4					
Ear length									
Mean	17.00		17.43	16.00	Sex	1	5.042	13.01	.005
SD	—		.54	.82	Within	10	.388		
SE	—		.20	.41					
CV	—		3.10	5.13					
n	1		7	4					
Tragus length									
Mean	6.00		7.00	5.75	Sex	1	3.375	6.00	.034
SD	—		.82	.50	Within	10	.563		
SE	—		.31	.25					
CV	—		11.71	8.70					
n	1		7	4					
Forearm length									
Mean	48.00		50.86	51.00	Sex	1	.667	.42	.533
SD	—		1.07	.82	Within	10	1.600		
SE	—		.40	.41					
CV	—		2.10	1.61					
n	1		7	4					
Weight									
Mean	12.00		12.14	13.25	Sex	1	3.375	10.80	.008
SD	—		.38	.87	Within	10	.313		
SE	—		.14	.43					
CV	—		3.13	6.57					
n	1		7	4					
Length of digit one									
Mean	8.00		8.43	8.00	Sex	1	.375	2.00	.188
SD	—		.54	0	Within	10	.188		
SE	—		.20	0					
CV	—		6.41	0					
n	1		7	4					

Table 5.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of digit three					
Mean	78.00		78.86	80.25	Sex	1	6.000	1.75	.215
SD	—		2.04	1.71	Within	10	3.435		
SE	—		.77	.85					
CV	—		2.59	2.13					
n	1		7	4					
				Length of digit four					
Mean	56.00		58.28	59.00	Sex	1	2.677	1.33	.275
SD	—		1.50	.82	Within	10	2.000		
SE	—		.57	.41					
CV	—		2.57	1.39					
n	1		7	4					
				Length of digit five					
Mean	57.00		58.29	59.00	Sex	1	2.042	1.59	.237
SD	—		1.25	.82	Within	10	1.288		
SE	—		.48	.41					
CV	—		2.14	1.40					
n	1		7	4					
				Tibia length					
Mean	21.00		21.14	21.25	Sex	1	.042	.07	.791
SD	—		.90	.50	Within	10	.563		
SE	—		.34	.25					
CV	—		4.26	2.35					
n	1		7	4					
				Calcar length					
Mean	22.00		21.29	22.00	Sex	1	1.042	1.77	.213
SD	—		.76	.82	Within	10	.588		
SE	—		.29	.41					
CV	—		3.57	3.73					
n	1		7	4					
				Greatest length of skull					
Mean	15.80		15.97	15.70	Sex	1	.167	2.78	.127
SD	—		.24	.27	Within	10	.060		
SE	—		.09	.14					
CV	—		1.50	1.72					
n	1		7	4					
				Condylobasal length					
Mean	15.10		15.44	15.30	Sex	1	.027	.36	.562
SD	—		.30	.18	Within	10	.074		
SE	—		.11	.09					
CV	—		1.94	1.18					
n	1		7	4					
				Zygomatic breadth					
Mean	9.60		9.70	9.60	Sex	1	.020	.89	.367
SD	—		.18	.08	Within	10	.023		
SE	—		.07	.04					
CV	—		1.86	.83					
n	1		7	4					

Table 5.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Postorbital constriction					
Mean	4.00		4.04	3.93	Sex	1	.034	3.91	.076
SD	—		.10	.10	Within	10	.009		
SE	—		.04	.05					
CV	—		2.48	2.54					
n	1		7	4					
				Mastoid breadth					
Mean	9.50		9.54	9.40	Sex	1	.050	1.69	.223
SD	—		.18	.18	Within	10	.030		
SE	—		.07	.09					
CV	—		1.89	1.91					
n	1		7	4					
				Breadth of braincase					
Mean	8.50		8.51	8.35	Sex	1	.707	3.54	.089
SD	—		.12	.19	Within	10	.020		
SE	—		.05	.10					
CV	—		1.41	2.28					
n	1		7	4					
				Rostral breadth					
Mean	5.10		5.21	5.13	Sex	1	.015	1.40	.265
SD	—		.12	.05	Within	10	.011		
SE	—		.05	.03					
CV	—		2.30	.97					
n	1		7	4					
				Height of braincase					
Mean	10.00		9.96	9.73	Sex	1	.150	3.70	.083
SD	—		.24	.15	Within	10	.041		
SE	—		.09	.08					
CV	—		2.41	1.54					
n	1		7	4					
				Breadth across the upper molars					
Mean	6.60		6.60	6.60	Sex	1	.000	0	1.000
SD	—		.14	.08	Within	10	.014		
SE	—		.05	.04					
CV	—		2.12	1.21					
n	1		7	4					
				Breadth across the upper canines					
Mean	5.30		5.49	5.50	Sex	1	.004	.16	.700
SD	—		.15	.16	Within	10	.024		
SE	—		.06	.08					
CV	—		2.73	2.91					
n	1		7	4					
				Length of the maxillary toothrow					
Mean	7.00		7.16	7.05	Sex	1	.020	.62	.449
SD	—		.21	.13	Within	10	.033		
SE	—		.08	.07					
CV	—		2.93	1.84					
n	1		7	4					
				Length of the upper molariform toothrow					
Mean	5.40		5.64	5.68	Sex	1	.010	.76	.402
SD	—		.05	.15	Within	10	.014		
SE	—		.02	.08					
CV	—		.89	2.64					
n	1		7	4					

Table 5.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Width of the widest molar									
Mean	1.90		1.87	1.93	Sex	1	.007	1.07	.326
SD	—		.08	.10	Within	10	.006		
SE	—		.03	.05					
CV	—		4.28	5.18					
n	1		7	4					
Greatest length of the mandible									
Mean	12.70		12.69	12.70	Sex	1	.000	.01	.920
SD	—		.23	.16	Within	10	.039		
SE	—		.09	.08					
CV	—		1.81	1.26					
n	1		7	4					
Length of the mandibular toothrow									
Mean	7.40		7.54	7.50	Sex	1	.002	.14	.711
SD	—		.08	.14	Within	10	.012		
SE	—		.03	.07					
CV	—		1.06	1.87					
n	1		7	4					
Length of the coronoid process									
Mean	3.00		3.14	3.15	Sex	1	.002	.37	.556
SD	—		.05	.06	Within	10	.005		
SE	—		.02	.03					
CV	—		1.59	1.90					
n	1		7	4					

characters, only tragus length exhibits statistically significant secondary sexual variation and no trend is evident when comparing female and male mean values. Nevertheless, the sample means for males are larger than those for females for 15 of the 16 cranial characters with differences in cranial characters statistically significant for mastoid breadth, width of the widest molar, length from the canine to the last molar in the mandible and length of the coronoid process. It appears then, that the sample means for males are consistently larger than those for females when cranial charaeters are considered but that similar trends are not apparent for external characteristics. The evidence from the Northeast of Brazil suggests the possibility of sexual dimorphism for *M. m. megalotis*, however, larger samples are required to make such a statement with complete statistical confidence.

Micronycteris minuta (Gervais, 1856)

Specimens in this monotypic species are listed as *Micronycteris* sp. by Mares et al. (1981). It is a foliage gleaning insectivore that was rare in the Caatingas, where it was most frequently caught near lajeiros or serrotes. *M. minuta* is also rare on the Chapada do Araripe.

Measurements of *M. minuta* have not appeared frequently in the literature (see Swanepoel and Genoways, 1979); however, Dobson (1878), Andersen (1906), G. M. Allen (1908), and Cunha Vieira (1942) included Brazilian specimens in their work. The only comparative morphometric work on the species was done by Sanborn (1949); he suggested that Colombian specimens are smaller than specimens from Brazil, however, his analysis was not conclusive.

The existence of sexual dimorphism was examined via the analysis of variance for specimens from the Northeast of Brazil. Specimens from the Caatingas and Chapada were combined due to small sample size and the results are shown in Table 7. None of the cranial characters and only two external characters exhibit statistically significant sexual variation. Because there is no apparent pattern in the relationship between male and female mean values either, there is little reason for considering specimens of *M. minuta* sufficiently dimorphic to war-

Table 6.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Micronycteris megalotis *males and females from both Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant* (P < *.050) secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	59.86	60.00	58.67		Sex	1	.714	.06	.805
SD	2.91	2.00	5.86		Within	12	11.208		
SE	1.10	1.00	3.38						
CV	4.86	3.33	9.99						
n	7	4	3						
Tail length									
Mean	13.57	13.00	14.67		Sex	1	2.314	.96	.346
SD	1.40	1.41	2.08		Within	12	2.408		
SE	.53	.71	1.20						
CV	10.32	10.85	14.17						
n	7	4	3						
Hindfoot length									
Mean	8.14	8.00	8.00		Sex	1	.029	.12	.737
SD	.38	0	1.00		Within	12	.242		
SE	.14	0	.58						
CV	4.67	0	12.50						
n	7	4	3						
Ear length									
Mean	20.86	21.25	20.33		Sex	1	.864	2.14	.169
SD	.69	.50	.58		Within	12	.404		
SE	.26	.25	.33						
CV	3.31	2.35	2.85						
n	7	4	3						
Tragus length									
Mean	7.57	6.75	8.00		Sex	1	2.579	10.86	.006
SD	.53	.50	0		Within	12	.238		
SE	.20	.25	0						
CV	7.13	7.41	0						
n	7	4	3						
Forearm length									
Mean	34.29	34.75	34.33		Sex	1	.579	1.01	.334
SD	.76	.50	1.16		Within	12	.571		
SE	.29	.25	.67						
CV	2.22	1.44	3.38						
n	7	4	3						
Weight									
Mean	5.93	5.75	6.67		Sex	1	.457	.75	.402
SD	.54	.29	1.44		Within	12	.606		
SE	.20	.14	.83						
CV	9.11	5.04	21.59						
n	7	4	3						
Length of digit one									
Mean	8.43	8.25	9.00		Sex	1	.350	1.33	.271
SD	.54	.50	0		Within	12	.263		
SE	.20	.25	0						
CV	6.41	6.06	0						
n	7	4	3						

Table 6.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	61.00	62.50	63.67		Sex	1	1.400	.24	.635
SD	2.00	1.00	3.79		Within	12	5.883		
SE	.76	.50	2.19						
CV	3.28	1.60	5.95						
n	7	4	3						
Length of digit four									
Mean	46.57	46.75	47.00		Sex	1	.007	.00	.947
SD	1.40	1.26	1.00		Within	12	1.571		
SE	.53	.63	.58						
CV	3.01	2.70	2.13						
n	7	4	3						
Length of digit five									
Mean	47.71	48.00	48.33		Sex	1	.029	.01	.918
SD	1.80	.82	2.08		Within	12	2.575		
SE	.68	.41	1.20						
CV	3.77	1.71	4.30						
n	7	4	3						
Tibia length									
Mean	16.71	15.75	16.67		Sex	1	2.579	2.41	.147
SD	1.25	.50	1.16		Within	12	1.071		
SE	.47	.25	.67						
CV	7.48	3.17	6.96						
n	7	4	3						
Calcar length									
Mean	11.00	10.75	10.67		Sex	1	.064	.10	.756
SD	1.00	.50	.58		Within	12	.638		
SE	.38	.25	.33						
CV	9.09	4.65	5.44						
n	7	4	3						
Noseleaf length									
Mean	6.42	7.00	7.00		Sex	1	.457	.86	.373
SD	.79	0	1.00		Within	12	.533		
SE	.30	0	.58						
CV	12.31	0	14.29						
n	7	4	3						
Greatest length of skull									
Mean	18.18	17.73	18.17		Sex	1	.568	2.81	.122
SD	.44	.31	.70		Within	11	.202		
SE	.18	.16	.41						
CV	2.42	1.75	3.85						
n	6	4	3						
Condylobasal length									
Mean	16.17	15.58	16.20		Sex	1	1.006	4.49	.058
SD	.57	.13	.62		Within	11	.224		
SE	.23	.06	.36						
CV	3.53	.83	3.83						
n	6	4	3						
Zygomatic breadth									
Mean	8.88	8.67	8.90		Sex	1	.106	1.86	.206
SD	.33	.12	.17		Within	9	.057		
SE	.15	.07	.10						
CV	3.72	1.38	1.91						
n	5	3	3						

Table 6.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Postorbital constriction					
Mean	3.85	3.78	3.77		Sex	1	.006	.30	.592
SD	.18	.05	.15		Within	10	.020		
SE	.07	.03	.09						
CV	4.68	1.32	3.98						
n	6	4	3						
				Mastoid breadth					
Mean	8.54	8.33	8.70		Sex	1	.202	5.20	.046
SD	.17	.13	.30		Within	10	.039		
SE	.08	.06	.17						
CV	1.99	1.56	3.45						
n	5	4	3						
				Breadth of braincase					
Mean	7.38	7.35	7.63		Sex	1	.042	1.03	.334
SD	.16	.13	.25		Within	10	.041		
SE	.07	.07	.15						
CV	2.17	1.77	3.28						
n	5	4	3						
				Rostral breadth					
Mean	3.26	3.23	3.27		Sex	1	.004	.14	.711
SD	.13	.17	.23		Within	12	.024		
SE	.05	.09	.13						
CV	3.99	5.26	7.03						
n	7	4	3						
				Height of braincase					
Mean	9.48	9.35	9.43		Sex	1	.034	.44	.522
SD	.34	.24	.31		Within	11	.086		
SE	.14	.12	.18						
CV	3.59	2.57	3.29						
n	6	4	3						
				Breadth across the upper molars					
Mean	6.02	5.85	5.93		Sex	1	.053	3.28	.097
SD	.08	.13	.21		Within	11	.016		
SE	.03	.07	.12						
CV	1.33	2.22	3.54						
n	6	4	3						
				Breadth across the upper canines					
Mean	3.15	3.20	3.17		Sex	1	.006	.49	.498
SD	.11	.12	.12		Within	11	.011		
SE	.04	.06	.07						
CV	3.49	3.75	3.79						
n	6	4	3						
				Length of the maxillary toothrow					
Mean	6.80	6.60	6.93		Sex	1	.165	1.02	.333
SD	.55	.08	.21		Within	12	.162		
SE	.21	.04	.12						
CV	8.09	1.21	3.03						
n	7	4	3						
				Length of the upper molariform toothrow					
Mean	5.73	5.50	5.97		Sex	1	.179	1.12	.310
SD	.54	.10	.15		Within	12	.159		
SE	.20	.05	.09						
CV	9.42	1.82	2.51						
n	7	4	3						

Table 6.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Width of the widest molar									
Mean	1.69	1.55	1.73		Sex	1	.064	8.57	.013
SD	.09	.10	.06		Within	12	.008		
SE	.03	.05	.03						
CV	5.33	6.45	3.47						
n	7	4	3						
Greatest length of the mandible									
Mean	11.79	11.40	11.73		Sex	1	.391	2.93	.113
SD	.44	.18	.42		Within	12	.113		
SE	.17	.09	.24						
CV	3.73	1.58	3.58						
n	7	4	3						
Length of the mandibular toothrow									
Mean	7.50	7.18	7.50		Sex	1	.302	5.77	.033
SD	.29	.10	.20		Within	12	.052		
SE	.11	.05	.12						
CV	3.87	1.39	2.67						
n	7	4	3						
Length of the coronoid process									
Mean	3.87	3.68	3.93		Sex	1	.132	10.13	.008
SD	.14	.05	.12		Within	12	.013		
SE	.05	.03	.07						
CV	3.62	1.36	3.05						
n	7	4	3						

Table 7.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Micronycteris minuta *males and females from both Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant (*P < .050*) secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	54.75	56.00	63.00		Sex	1	10.971	.70	.427
SD	.50	1.00	1.73		Within	8	15.679		
SE	.25	.58	1.00						
CV	.91	1.79	2.74						
n	4	3	3						
Tail length									
Mean	11.25	12.00	12.33		Sex	1	.171	.12	.738
SD	.96	1.00	1.53		Within	8	1.429		
SE	.48	.58	.88						
CV	8.53	8.33	12.41						
n	4	3	3						
Hindfoot length									
Mean	8.50	8.67	8.67		Sex	1	.019	.06	.807
SD	.58	.58	.58		Within	8	.298		
SE	.29	.33	.33						
CV	6.82	6.70	6.69						
n	4	3	3						

Table 7.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Ear length									
Mean	18.50	19.33	26.00		Sex	1	.476	.28	.610
SD	1.00	.58	4.58		Within	8	1.691		
SE	.50	.33	2.65						
CV	5.41	3.00	17.62						
n	4	3	3						
Tragus length									
Mean	7.00	7.00	7.00						
SD	0	0	0						
SE	0	0	0						
CV	0	0	0						
n	4	3	3						
Forearm length									
Mean	32.75	34.00	34.00		Sex	1	1.071	1.15	.314
SD	.96	0	1.00		Within	8	.929		
SE	.48	0	.58						
CV	2.93	0	2.94						
n	4	3	3						
Weight									
Mean	5.75	6.83	5.67		Sex	1	2.630	5.85	.042
SD	.29	1.26	.29		Within	8	.449		
SE	.14	.73	.17						
CV	5.04	18.45	5.11						
n	4	3	3						
Length of digit one									
Mean	6.25	7.00	6.67		Sex	1	.686	3.20	.111
SD	.50	0	.58		Within	8	.214		
SE	.25	0	.33						
CV	8.00	0	8.70						
n	4	3	3						
Length of digit three									
Mean	54.50	57.33	56.67		Sex	1	7.619	2.99	.122
SD	.58	2.31	.58		Within	8	2.548		
SE	.29	1.33	.33						
CV	1.06	4.03	1.02						
n	4	3	3						
Length of digit four									
Mean	41.50	43.33	42.67		Sex	1	3.733	1.45	.264
SD	1.29	2.52	.58		Within	8	2.583		
SE	.65	1.45	.33						
CV	3.11	5.82	1.36						
n	4	3	3						
Length of digit five									
Mean	41.50	44.00	42.67		Sex	1	8.400	5.60	.046
SD	1.00	1.73	.58		Within	8	1.500		
SE	.50	1.00	.33						
CV	3.77	3.93	1.36						
n	4	3	3						
Tibia length									
Mean	15.00	15.33	16.00		Sex	1	.019	.02	.896
SD	.82	1.16	1.00		Within	8	1.048		
SE	.41	.67	.58						
CV	5.47	7.57	6.25						
n	4	3	3						

Table 7.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Calcar length									
Mean	8.75	9.00	9.67		Sex	1	.043	.04	.849
SD	.96	1.00	1.16		Within	8	1.107		
SE	.48	.58	.67						
CV	10.97	11.11	12.00						
n	4	3	3						
Noseleaf length									
Mean	5.25	5.33	5.33		Sex	1	.005	.02	.896
SD	.50	.58	.58		Within	8	.262		
SE	.25	.33	.33						
CV	9.52	10.88	10.88						
n	4	3	3						
Greatest length of skull									
Mean	16.80	16.77	16.95		Sex	1	.014	.12	.735
SD	.41	.32	.21		Within	7	.112		
SE	.20	.19	.15						
CV	2.44	1.91	1.24						
n	4	3	2						
Condylobasal length									
Mean	14.83	14.93	15.00		Sex	1	.005	.10	.763
SD	.29	.15	.14		Within	7	.051		
SE	.14	.09	.10						
CV	1.96	1.00	.93						
n	4	3	2						
Zygomatic breadth									
Mean	7.93	8.10	8.00		Sex	1	.030	4.00	.116
SD	.96	.14	—		Within	4	.008		
SE	.03	.10	—						
CV	.76	1.73	—						
n	3	2	1						
Postorbital constriction									
Mean	3.75	3.90	4.03		Sex	1	.002	.05	.835
SD	.17	.17	.06		Within	8	.037		
SE	.09	.10	.03						
CV	4.53	4.36	1.49						
n	4	3	3						
Mastoid breadth									
Mean	8.15	8.18	8.40		Sex	1	.009	.19	.673
SD	.24	.15	.14		Within	7	.046		
SE	.12	.09	.10						
CV	2.94	1.84	1.67						
n	4	3	2						
Breadth of braincase									
Mean	7.25	7.23	7.40		Sex	1	.005	.18	.685
SD	.13	.21	.14		Within	7	.028		
SE	.06	.12	.10						
CV	1.79	2.90	1.89						
n	4	3	2						
Rostral breadth									
Mean	2.98	2.90	3.03		Sex	1	.021	4.20	.075
SD	.05	.10	.06		Within	8	.005		
SE	.03	.06	.03						
CV	1.68	3.45	1.98						
n	4	3	3						

Table 7.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Height of braincase									
Mean	8.90	8.93	8.90		Sex	1	.002	.04	.838
SD	.29	.21	0		Within	7	.050		
SE	.15	.21	0						
CV	3.26	2.35	0						
n	4	3	2						
Breadth across the upper molars									
Mean	5.03	5.07	5.27		Sex	1	.008	.46	.518
SD	.05	.06	.12		Within	8	.018		
SE	.03	.03	.07						
CV	.99	1.18	2.28						
n	4	3	3						
Breadth across the upper canines									
Mean	2.73	2.67	2.87		Sex	1	.030	2.50	.153
SD	.05	.06	.15		Within	8	.012		
SE	.03	.03	.09						
CV	1.83	2.25	5.23						
n	4	3	3						
Length of the maxillary toothrow									
Mean	5.75	5.97	5.73		Sex	1	.015	5.14	.053
SD	.06	.25	.12		Within	8	.021		
SE	.03	.15	.07						
CV	1.04	4.19	2.09						
n	4	3	3						
Length of the upper molariform toothrow									
Mean	4.88	4.90	4.90		Sex	1	.000	.03	.863
SD	.10	.17	.10		Within	8	.014		
SE	.05	.10	.06						
CV	2.05	3.47	2.04						
n	4	3	3						
Width of the widest molar									
Mean	1.38	1.43	1.33		Sex	1	.012	4.10	.078
SD	.05	.06	.06		Within	8	.003		
SE	.03	.03	.03						
CV	3.62	4.20	4.51						
n	4	3	3						
Greatest length of the mandible									
Mean	10.43	10.43	10.47		Sex	1	.000	.02	.896
SD	.10	.06	.15		Within	8	.011		
SE	.05	.03	.09						
CV	.96	.58	1.43						
n	4	3	3						
Length of the mandibular toothrow									
Mean	6.28	6.27	6.05		Sex	1	.009	.27	.617
SD	.17	.12	.21		Within	7	.032		
SE	.09	.07	.15						
CV	2.71	1.91	3.47						
n	4	3	2						
Length of the coronoid process									
Mean	3.05	3.10	3.27		Sex	1	.004	.26	.622
SD	.06	.10	.06		Within	8	.015		
SE	.03	.06	.03						
CV	1.97	3.23	1.83						
n	4	3	3						

rant analyzing males and females separately in future analyses.

Tonatia bidens (Spix, 1823)

T. b. bidens is the only extant subspecies currently recognized (Jones and Carter, 1976). This foliage gleaning insectivore was rare in the Caatingas where it was only captured on serrotes; it was apparently absent from the Chapada do Araripe.

Few mensural data are reported in the literature for *T. bidens*. Dobson (1879), Lima (1926), Sanborn (1936), Cunha Vieira (1942), and Goodwin (1942) reported measurements from Brazilian specimens. Only selected measurements (after Swanepoel and Genoways, 1979) are reported here for the two adult males and one adult female captured in the Caatingas (total length, 85, 96, 93; tail length, 18, 19, 18; hindfoot length, 14, 14, 13; ear length, 32, 30, 33; greatest length of skull, 27.4, 27.3, 27.1; condylobasal length, 24.1, 23.1, 23.6; zygomatic breadth, 14.3, 14.0, 14.0; postorbital constriction, 5.7, 5.3, 5.2; breadth of braincase, 11.0, 10.7, 10.7; length of the maxillary toothrow, 9.8, 9.8, 9.5; breadth across the upper molars, 8.6, 8.8, 8.5).

Tonatia brasiliense (Peters, 1866)

Jones and Carter (1976) consider *T. brasiliense* to be monotypic; however, if one includes specimens of *T. venezuelae, T. minuta*, and *T. nicaraguae* within this taxon as is frequently done (Gardner, 1976; Koopman, 1978), then the species is, no doubt, polytypic. It was uncommon in the Caatingas but was consistently captured on serrotes or in Caatinga Alta habitats. *T. brasiliense* was absent from all habitats on Chapada do Araripe.

Most of the recorded measurements for *T. brasiliense* were derived from Peters (1866) original description of the holotype. Goodwin (1942) presented data on two more specimens from Brazil and Gardner (1976) presented data on two additional specimens from Peru. Samples from the Caatingas are too small to allow statistical analyses, therefore data are reported here on a selected set of mensural characters (after Swanepoel and Genoways, 1979). The first figure represents the mean value derived from six adult females, whereas the second figure represents the mean value derived from two adult males (total length, 69.8, 75.0; tail length, 9.2, 11.0; hindfoot length, 9.8, 10.0; ear length, 23.8, 22.0; greatest length of skull, 20.44, 19.95; condylobasal length, 17.86, 17.40; zygomatic breadth, 10.30, 9.95; postorbital constriction, 3.23, 3.25; breadth of braincase, 8.42, 8.25; length of maxillary toothrow, 8.18, 8.10; breadth across the upper molars, 6.62, 6.45).

Tonatia silvicola (D'Orbigny, 1836)

Two subspecies are currently recognized in this taxon; *T. s. laephotis* is the designation appropriate for specimens from northeastern Brazil (Jones and Carter, 1976). This foliage gleaning insectivore is absent from the Chapada do Araripe, and its occurrence in the Caatingas was primarily restricted to serrotes. All but three of the specimens from the Northeast of Brazil listed by Mares et al. (1981) as *T. bidens* were actually *T. silvicola*. Based upon netting records for adult specimens from the duration of this study, the sex ratio was not equal in this species (Bionomial test, $P < .05$); approximately 30% of the 47 captured adult individuals were males.

Swanepoel and Genoways (1979) summarized the sources of recorded measurements for *T. silvicola*; Peters (1865), Dobson (1878), Cunha Vieira (1942), and Goodwin (1942) are noteworthy in that listing because they have included Brazilian specimens in their work. Statistical analyses of individual variation have not been done nor has the existence of sexual dimorphism been considered in the literature. Samples are sufficiently large from the Caatingas to determine individual variation and ascertain with confidence the degree of sexual dimorphism present in a population of *T. silvicola*. The results of the statistical analysis are presented in Table 8. The sample means for males are larger than the sample means for females for 24 of the 30 characters examined. Statistically significant secondary sexual variation is revealed for two external characters (ear length and weight) and six cranial characters (greatest length of skull, condylobasal length, zygomatic breadth, mastoid breadth, height of the braincase, and length in the mandible from the canine to the last molar). Statistical significance is not found in the variables that had larger sample mean values for females. *T. silvicola* is clearly dimorphic for cranial characters with males larger than females.

Mimon crenulatum (E. Geoffroy, 1819)

Jones and Carter (1976) recognize four subspecies in this taxon, whereas Koopman (1978) includes a fifth form. In either case, *M. c. crenulatum* is the designation properly applied to specimens from northeastern Brazil. This foliage gleaning insectivore was found exclusively in Caatinga Alta habitats.

A paucity of data exists concerning the morphometrics of *M. crenulatum* (see Swanepoel and Gen-

Table 8.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Tonatia silvicola *males and females from the Caatinga biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	97.85	97.58			Sex	1	.660	.07	.799
SD	3.34	3.12			Within	47	10.095		
SE	.93	.52							
CV	3.41	3.20							
n	13	36							
Tail length									
Mean	17.69	17.69			Sex	1	.000	.00	.998
SD	2.50	2.04			Within	47	4.690		
SE	.69	.34							
CV	14.13	11.53							
n	13	36							
Hindfoot length									
Mean	14.62	14.69			Sex	1	.060	.11	.747
SD	.51	.82			Within	47	.568		
SE	.14	.14							
CV	3.49	5.58							
n	13	36							
Ear length									
Mean	29.62	28.81			Sex	1	6.264	7.60	.008
SD	1.12	.82			Within	47	.824		
SE	.31	.14							
CV	3.78	2.85							
n	13	36							
Tragus length									
Mean	11.69	11.86			Sex	1	.272	.28	.597
SD	1.38	.80			Within	47	.959		
SE	.38	.13							
CV	11.80	6.74							
n	13	36							
Forearm length									
Mean	58.23	57.58			Sex	1	4.004	3.30	.076
SD	1.42	.97			Within	47	1.214		
SE	.40	.16							
CV	2.44	1.68							
n	13	36							
Weight									
Mean	33.85	31.79			Sex	1	40.314	5.06	.029
SD	3.07	2.73			Within	47	7.966		
SE	.85	.46							
CV	9.07	8.59							
n	13	36							
Length of digit one									
Mean	15.08	14.94			Sex	1	.168	.23	.637
SD	.76	.89			Within	47	.741		
SE	.21	.15							
CV	5.04	5.96							
n	13	36							

Table 8.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	106.54	106.00			Sex	1	2.769	.65	.423
SD	2.63	1.82			Within	47	4.239		
SE	.73	.30							
CV	2.47	1.72							
n	13	36							
Length of digit four									
Mean	80.46	79.81			Sex	1	4.110	1.26	.267
SD	2.37	1.56			Within	47	3.253		
SE	.66	.26							
CV	2.95	1.95							
n	13	36							
Length of digit five									
Mean	81.39	80.47			Sex	1	7.951	3.06	.087
SD	2.40	1.23			Within	47	2.597		
SE	.67	.21							
CV	2.95	1.53							
n	13	36							
Tibia length									
Mean	27.08	27.25			Sex	1	.286	.25	.619
SD	1.66	.77			Within	47	1.142		
SE	.46	.13							
CV	6.13	2.83							
n	13	36							
Calcar length									
Mean	18.54	17.78			Sex	1	5.527	3.35	.073
SD	1.33	1.27			Within	47	1.648		
SE	.37	.21							
CV	7.17	7.14							
n	13	36							
Noseleaf length									
Mean	6.54	6.33			Sex	1	.402	1.68	.201
SD	.52	.48			Within	47	.239		
SE	.14	.08							
CV	7.95	7.58							
n	13	36							
Greatest length of skull									
Mean	27.80	27.32			Sex	1	2.180	7.93	.007
SD	.54	.52			Within	47	.275		
SE	.15	.09							
CV	1.94	1.90							
n	13	36							
Condylobasal length									
Mean	24.31	23.84			Sex	1	2.050	14.56	<.001
SD	.50	.32			Within	47	.141		
SE	.14	.05							
CV	2.06	1.34							
n	13	36							
Zygomatic breadth									
Mean	13.68	13.47			Sex	1	.412	6.82	.012
SD	.24	.25			Within	45	.060		
SE	.07	.04							
CV	1.75	1.86							
n	13	34							

Table 8.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	6.00	6.00			Sex	1	.000	.00	.967
SD	.15	.22			Within	47	.042		
SE	.04	.04							
CV	2.50	3.67							
n	13	36							
Mastoid breadth									
Mean	13.49	13.27			Sex	1	.454	7.42	.009
SD	.20	.26			Within	46	.061		
SE	.05	.05							
CV	1.48	1.96							
n	13	35							
Breadth of braincase									
Mean	11.03	11.10			Sex	1	.042	.92	.343
SD	.19	.22			Within	47	.046		
SE	.05	.04							
CV	1.72	1.98							
n	13	36							
Rostral breadth									
Mean	5.99	5.92			Sex	1	.047	1.68	.201
SD	.19	.16			Within	47	.028		
SE	.05	.03							
CV	3.17	2.70							
n	13	36							
Height of braincase									
Mean	13.96	13.73			Sex	1	.534	6.65	.013
SD	.32	.27			Within	47	.080		
SE	.09	.05							
CV	2.29	1.97							
n	13	36							
Breadth across the upper molars									
Mean	8.90	8.84			Sex	1	.030	.89	.349
SD	.22	.17			Within	47	.033		
SE	.06	.03							
CV	2.47	1.92							
n	13	36							
Breadth across the upper canines									
Mean	6.12	6.05			Sex	1	.055	2.00	.164
SD	.15	.17			Within	47	.028		
SE	.04	.03							
CV	2.45	2.81							
n	13	36							
Length of the maxillary toothrow									
Mean	10.12	10.03			Sex	1	.092	3.69	.061
SD	.21	.14			Within	47	.025		
SE	.06	.02							
CV	2.08	1.40							
n	13	36							
Length of the upper molariform toothrow									
Mean	7.96	7.93			Sex	1	.011	.45	.507
SD	.16	.15			Within	47	.024		
SE	.04	.03							
CV	2.01	1.89							
n	13	36							

Table 8.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Width of the widest molar					
Mean	2.42	2.45			Sex	1	.010	1.12	.296
SD	.10	.09			Within	47	.009		
SE	.03	.02							
CV	4.13	3.67							
n	13	36							
				Greatest length of the mandible					
Mean	18.10	17.98			Sex	1	.130	1.33	.256
SD	.34	.31			Within	47	.098		
SE	.09	.05							
CV	1.88	1.72							
n	13	36							
				Length of the mandibular toothrow					
Mean	11.29	11.09			Sex	1	.366	6.16	.017
SD	.22	.25			Within	47	.059		
SE	.06	.04							
CV	1.95	2.25							
n	13	36							
				Length of the coronoid process					
Mean	7.35	7.25			Sex	1	.098	2.27	.139
SD	.21	.21			Within	47	.043		
SE	.06	.03							
CV	2.86	2.90							
n	13	36							

oways, 1979). Peters (1866), Dobson (1878), Thomas (1903), Cunha Vieira (1942), and Handley (1960) included specimens from Brazil in their work, but statistical analyses were not attempted. Samples from the Caatingas are sufficiently large to perform statistical analyses; the results are shown in Table 9. Only a single character, condylobasal length, exhibits statistically significant secondary sexual variation and trends in the relationship of male and female mean values could not be detected for the other variables. The data cannot substantiate the presence of sexual dimorphism in the Caatingas population of *M. c. crenulatum*, but this failure may be due to small sample sizes.

Phyllostomus discolor (Wagner, 1843)

Power and Tamsitt (1973) recently suggested that *P. discolor* is a monotypic species because there is little morphometric basis for distinguishing between the two presently recognized subspecies. In keeping with current usage, however, *P. d. discolor* is the appropriate appellation for populations east of the Andes (Jones and Carter, 1976) and would thus apply to specimens from northeastern Brazil. Although primarily frugivorous, at least part of the year *P. d. discolor* consumed nectar, pollen, flower parts, and insects; thus, it should be considered omnivorous. Based upon pollen loads from Cerrado specimens, *P. d. discolor* was an important pollinator of *Caryocar coriaceum*. In fact, the number of captured specimens of this species increased fourfold during months when *C. coriaceum* flowered; this strongly suggests recruitment from surrounding areas as preferred resources became abundant on the Chapada. *P. d. discolor* was widespread and abundant on the Chapada do Araripe but restricted for the most part to banana and mango orchards in the Caatingas. Thirty-eight percent of the 26 captured adult specimens from the Caatingas were males; similarly, 36% of the 180 captured adult specimens from the Chapada do Araripe were males. In the Cerrado, *P. d. discolor* exhibited a significantly unequal sex ratio (Binomial Test, $P < .01$). Samples from the Caatingas failed to exhibit a significantly unequal sex ratio (Binomial Test, $P > .05$), but this may be attributed in part to the small sample size available from this study. Numerous authors have reported measurements for *P. discolor* (see Swanepoel and Genoways, 1979) but only Peters (1865), Cunha Vieira (1942), Power and Tamsitt

Table 9.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Mimon crenulatum *males and females from the Caatinga biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	79.00	84.50			Sex	1	51.857	3.99	.102
SD	4.36	3.00			Within	5	13.000		
SE	2.52	1.50							
CV	5.52	3.55							
n	3	4							
Tail length									
Mean	23.00	22.00			Sex	1	1.714	.36	.616
SD	1.73	2.45			Within	5	4.800		
SE	1.00	1.23							
CV	7.52	11.14							
n	3	4							
Hindfoot length									
Mean	10.00	9.75			Sex	1	.107	.71	.437
SD	0	.50			Within	5	.150		
SE	0	.25							
CV	0	5.13							
n	3	4							
Ear length									
Mean	26.00	26.50			Sex	1	.429	2.14	.203
SD	0	.58			Within	5	.200		
SE	0	.29							
CV	0	2.19							
n	3	4							
Tragus length									
Mean	11.67	11.25			Sex	1	.298	.16	.707
SD	1.53	1.26			Within	5	1.883		
SE	.88	.63							
CV	13.11	11.20							
n	3	4							
Forearm length									
Mean	45.00	46.75			Sex	1	5.250	5.53	.066
SD	1.00	.96			Within	5	.950		
SE	.58	.48							
CV	2.22	2.05							
n	3	4							
Weight									
Mean	11.67	11.25			Sex	1	.298	1.05	.352
SD	.58	.50			Within	5	.283		
SE	.33	.25							
CV	4.97	4.44							
n	3	4							
Length of digit one									
Mean	8.67	8.75			Sex	1	.012	.02	.900
SD	.58	.96			Within	5	.683		
SE	.33	.48							
CV	6.69	10.97							
n	3	4							

Table 9.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Length of digit three				
Mean	93.67	92.50			Sex	1	2.333	.13	.733
SD	6.03	2.38			Within	5	17.933		
SE	3.48	1.19							
CV	6.44	2.57							
n	3	4							
					Length of digit four				
Mean	65.33	66.00			Sex	1	.762	.26	.632
SD	2.52	.82			Within	5	2.933		
SE	1.45	.41							
CV	3.86	1.24							
n	3	4							
					Length of digit five				
Mean	62.33	65.00			Sex	1	12.191	1.87	.230
SD	3.06	2.16			Within	5	6.533		
SE	1.76	1.08							
CV	4.91	3.32							
n	3	4							
					Tibia length				
Mean	21.00	21.50			Sex	1	.429	.71	.437
SD	1.00	.58			Within	5	.600		
SE	.58	.30							
CV	4.76	2.70							
n	3	4							
					Calcar length				
Mean	19.67	21.00			Sex	1	3.048	.57	.484
SD	.58	2.94			Within	5	5.333		
SE	.33	1.47							
CV	2.95	14.00							
n	3	4							
					Noseleaf length				
Mean	15.67	13.75			Sex	1	6.298	2.76	.158
SD	2.08	.96			Within	5	2.283		
SE	1.20	.48							
CV	13.27	6.98							
n	3	4							
					Greatest length of skull				
Mean	19.93	20.10			Sex	1	.048	1.05	.352
SD	.21	.22			Within	5	.045		
SE	.12	.11							
CV	1.05	1.09							
n	3	4							
					Condylobasal length				
Mean	17.53	18.10			Sex	1	.551	21.73	.006
SD	.25	0			Within	5	.025		
SE	.15	0							
CV	1.43	0							
n	3	4							
					Zygomatic breadth				
Mean	11.53	11.45			Sex	1	.012	.20	.673
SD	.25	.24			Within	5	.059		
SE	.15	.12							
CV	2.17	2.10							
n	3	4							

Table 9.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	4.00	3.90			Sex	1	.017	.48	.521
SD	.27	.12			Within	5	.036		
SE	.15	.06							
CV	6.75	3.08							
n	3	4							
Mastoid breadth									
Mean	11.30	11.30			Sex	1	.000	0	1.000
SD	.20	.20			Within	5	.040		
SE	.12	.10							
CV	1.77	1.77							
n	3	4							
Breadth of braincase									
Mean	7.97	7.98			Sex	1	.000	.00	.950
SD	.21	.13			Within	5	.027		
SE	.12	.06							
CV	2.63	1.63							
n	3	4							
Rostral breadth									
Mean	5.03	4.88			Sex	1	.043	2.28	.191
SD	.15	.13			Within	5	.019		
SE	.09	.06							
CV	2.98	2.66							
n	3	4							
Height of braincase									
Mean	11.07	10.90			Sex	1	.048	2.75	.158
SD	.12	.14			Within	5	.017		
SE	.07	.07							
CV	1.08	1.28							
n	3	4							
Breadth across the upper molars									
Mean	8.13	7.93			Sex	1	.074	1.36	.297
SD	.31	.17			Within	5	.055		
SE	.18	.09							
CV	3.81	2.14							
n	3	4							
Breadth across the upper canines									
Mean	4.97	4.78			Sex	1	.063	4.25	.094
SD	.15	.10			Within	5	.015		
SE	.09	.05							
CV	3.02	2.09							
n	3	4							
Length of the maxillary toothrow									
Mean	7.13	7.15			Sex	1	.000	.14	.721
SD	.06	.06			Within	5	.003		
SE	.03	.03							
CV	.84	.84							
n	3	4							
Length of the upper molariform toothrow									
Mean	5.73	5.83			Sex	1	.014	.76	.422
SD	.21	.05			Within	5	.019		
SE	.12	.03							
CV	3.66	.86							
n	3	4							

Table 9.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Width of the widest molar									
Mean	2.23	2.33			Sex	1	.014	2.11	.206
SD	.06	.10			Within	5	.007		
SE	.03	.05							
CV	2.69	4.29							
n	3	4							
Greatest length of the mandible									
Mean	12.83	13.03			Sex	1	.063	1.24	.316
SD	.29	.17			Within	5	.051		
SE	.17	.09							
CV	2.26	1.30							
n	3	4							
Length of the mandibular toothrow									
Mean	7.93	7.68			Sex	1	.114	6.07	.057
SD	.15	.13			Within	5	.019		
SE	.09	.06							
CV	1.89	1.69							
n	3	4							
Length of the coronoid process									
Mean	4.13	4.18			Sex	1	.003	.06	.811
SD	.25	.19			Within	5	.047		
SE	.15	.10							
CV	6.05	4.55							
n	3	4							

(1973), and Taddei (1975*a*) considered Brazilian specimens in their work.

Valdez (1970) was unable to detect statistically significant secondary sexual variation in specimens of *P. discolor* utilizing univariate procedures on a number of morphometric characters. A multivariate analysis of variance on samples drawn from throughout the range of *P. discolor* has indicated strong sexual dimorphism while the subsequent use of discriminant function analysis indicated that mastoid breadth and to a lesser extent zygomatic breadth are important characters in distinguishing between the sexes (Power and Tamsitt, 1973). These authors cautioned, however, that the differences between males and females are not simply explained by size differentials but rather include subtle considerations of shape not detectable by univariate methods alone.

In samples restricted to southwestern São Paulo, Taddei (1975*a*) found males larger on the average than females for 17 external characters and 15 cranial characters. Statistically significant secondary sexual variation was found in breadth across the canines, breadth across the molars, zygomatic width, mastoid breadth, cranial depth, ear length, length of the second phalanx in digit III and length of the second phalanx in digit V. Strong sexual dimorphism is indicated by these results with males consistently larger than females.

The results of univariate analysis of 30 external and cranial characters on specimens from the Northeast of Brazil are shown in Table 10. Statistically significant geographic variation is observed in two cranial and two external characters (hindfoot length, length of digit IV, breadth of braincase, and length of the coronoid process). A consistent pattern for mean values is not evident–Caatingas populations have larger sample means than Cerrado populations for six characters, yet Cerrado populations have larger sample means than Caatingas populations for seven characters. In contrast, strong sexual dimorphism is evident. Males have larger sample means than females for eight external and eight cranial characters. Two external and nine cranial characters (forearm length, length of digit one, greatest length of skull, condylobasal length, mastoid breadth, breadth across the braincase, breadth across the upper molars, length of the maxillary tooth row, length

Table 10.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Phyllostomus discolor *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean	96.30	98.31	98.50	98.70	Area	1	25.505	2.28	.136
SD	4.08	3.14	3.58	2.83	Sex	1	18.648	1.67	.201
SE	1.29	.78	.80	.63	A × S	1	12.515	1.12	.294
CV	4.24	3.19	3.63	2.87	Error	62	11.173		
n	10	16	20	20					
				Tail length					
Mean	14.90	15.13	14.65	14.05	Area	1	7.736	3.91	.052
SD	1.66	1.31	1.47	1.28	Sex	1	.288	.15	.704
SE	.53	.33	.33	.29	A × S	1	2.002	1.01	.318
CV	11.14	18.66	10.10	9.11	Error	62	1.977		
n	10	16	20	20					
				Hindfoot length					
Mean	13.20	13.19	13.70	13.45	Area	1	2.215	4.14	.046
SD	.79	.66	.73	.76	Sex	1	.263	.49	.486
SE	.25	.16	.16	.17	A × S	1	.215	.40	.529
CV	5.98	5.00	5.33	5.65	Error	62	.535		
n	10	16	20	20					
				Ear length					
Mean	21.60	21.13	20.80	21.80	Area	1	.060	.03	.863
SD	1.35	1.15	1.15	1.80	Sex	1	1.050	.53	.469
SE	.43	.29	.26	.40	A × S	1	8.288	4.19	.045
CV	6.25	5.44	5.53	8.26	Error	62	1.977		
n	10	16	20	20					
				Tragus length					
Mean	8.90	8.81	9.05	9.00	Area	1	.434	.78	.379
SD	.74	.91	.61	.73	Sex	1	.072	.13	.719
SE	.23	.23	.14	.16	A × S	1	.005	.01	.922
CV	8.31	10.33	6.74	8.11	Error	62	.553		
n	10	16	20	20					
				Forearm length					
Mean	61.60	59.81	60.20	59.70	Area	1	8.715	3.14	.081
SD	1.84	1.52	1.80	1.56	Sex	1	19.934	7.18	.009
SE	.59	.38	.40	.35	A × S	1	6.315	2.27	.137
CV	2.99	2.54	2.99	2.61	Error	62	2.778		
n	10	16	20	20					
				Weight					
Mean	37.50	40.06	38.85	36.68	Area	1	15.815	1.49	.227
SD	3.27	3.29	2.16	4.05	Sex	1	.572	.05	.817
SE	1.03	.82	.48	.91	A × S	1	85.501	8.05	.006
CV	8.72	8.21	5.56	11.04	Error	62	10.615		
n	10	16	20	20					
				Length of digit one					
Mean	11.30	11.13	11.75	11.35	Area	1	1.736	4.46	.039
SD	.48	.50	.64	.75	Sex	1	1.260	3.23	.077
SE	.15	.13	.14	.17	A × S	1	.193	.50	.484
CV	4.25	4.49	5.45	6.61	Error	62	.390		
n	10	16	20	20					

Table 10.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	109.10	105.00	105.55	105.50	Area	1	35.438	3.33	.073
SD	3.60	2.68	2.46	4.10	Sex	1	65.610	6.17	.016
SE	1.14	.67	.55	.92	A × S	1	62.486	5.88	.018
CV	3.30	2.55	2.33	3.89	Error	62	10.627		
n	10	16	20	20					
Length of digit four									
Mean	80.70	78.31	78.65	78.15	Area	1	18.648	2.50	.119
SD	2.83	1.89	2.06	3.68	Sex	1	31.763	4.26	.043
SE	.90	.47	.46	.82	A × S	1	13.572	1.82	.182
CV	3.51	2.41	2.62	4.71	Error	62	7.462		
n	10	16	20	20					
Length of digit five									
Mean	73.40	71.63	71.85	71.35	Area	1	12.688	2.28	.136
SD	2.01	2.06	1.98	3.00	Sex	1	19.717	3.54	.065
SE	.64	.52	.44	.67	A × S	1	6.193	1.11	.296
CV	2.74	2.88	2.76	4.20	Error	62	5.569		
n	10	16	20	20					
Tibia length									
Mean	24.70	24.88	25.45	24.45	Area	1	.402	.26	.615
SD	1.83	.89	1.32	1.10	Sex	1	2.593	1.64	.205
SE	.58	.22	.29	.25	A × S	1	5.260	3.34	.073
CV	7.41	3.58	5.19	4.50	Error	62	1.577		
n	10	16	20	20					
Calcar length									
Mean	9.80	9.75	9.55	10.05	Area	1	.010	.01	.917
SD	.92	1.13	.95	.76	Sex	1	.771	.88	.353
SE	.29	.28	.21	.17	A × S	1	1.152	1.31	.257
CV	9.38	11.59	9.95	7.56	Error	62	.879		
n	10	16	20	20					
Noseleaf length									
Mean	6.70	6.19	6.50	6.40	Area	1	.001	.00	.972
SD	.48	.91	.51	.75	Sex	1	1.429	2.92	.092
SE	.15	.23	.12	.17	A × S	1	.648	1.32	.254
CV	7.16	14.70	7.85	11.72	Error	62	.489		
n	10	16	20	20					
Greatest length of skull									
Mean	29.22	29.18	29.44	28.65	Area	1	.345	1.06	.307
SD	.52	.61	.65	.47	Sex	1	2.562	7.87	.007
SE	.17	.15	.15	.11	A × S	1	2.016	6.19	.016
CV	1.78	2.09	2.21	1.64	Error	61	.326		
n	9	16	20	20					
Condylobasal length									
Mean	26.34	26.22	26.61	25.71	Area	1	.234	.80	.375
SD	.62	.51	.48	.58	Sex	1	3.845	13.10	.001
SE	.21	.13	.11	.13	A × S	1	2.191	7.47	.008
CV	2.35	1.95	1.80	2.26	Error	61	.294		
n	9	16	20	20					
Zygomatic breadth									
Mean	15.23	15.56	15.55	14.94	Area	1	.342	2.07	.156
SD	.46	.37	.39	.43	Sex	1	.288	1.74	.192
SE	.15	.09	.09	.10	A × S	1	3.224	19.48	<.001
CV	3.02	2.38	2.51	2.88	Error	61	.166		
n	9	16	20	20					

Table 10.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	6.47	6.38	6.38	6.37	Area	1	.035	.63	.432
SD	.15	.16	.26	.28	Sex	1	.033	.59	.444
SE	.05	.04	.06	.06	A × S	1	.021	.37	.545
CV	2.32	2.51	4.08	4.40	Error	61	.056		
n	9	16	20	20					
Mastoid breadth									
Mean	14.42	14.78	14.91	14.19	Area	1	.042	.38	.538
SD	.24	.38	.37	.32	Sex	1	.493	4.50	.038
SE	.08	.08	.08	.07	A × S	1	4.207	38.41	<.001
CV	1.66	2.23	2.48	2.26	Error	61	.110		
n	9	16	20	20					
Breadth of braincase									
Mean	12.13	12.03	12.04	11.82	Area	1	.339	5.10	.028
SD	.20	.18	.30	.29	Sex	1	.379	5.70	.020
SE	.07	.04	.07	.07	A × S	1	.051	.76	.385
CV	1.65	1.50	2.49	2.45	Error	61	.067		
n	9	16	20	20					
Rostral breadth									
Mean	6.74	6.96	7.07	6.67	Area	1	.003	.06	.815
SD	.29	.19	.23	.25	Sex	1	.129	2.27	.137
SE	.10	.05	.05	.06	A × S	1	.368	24.03	<.001
CV	4.30	2.73	3.25	3.75	Error	61	.057		
n	9	16	20	20					
Height of braincase									
Mean	13.18	13.33	13.33	12.99	Area	1	.122	.94	.336
SD	.43	.27	.30	.44	Sex	1	.136	1.05	.311
SE	.14	.07	.07	.10	A × S	1	.868	6.68	.012
CV	3.26	2.03	2.25	3.39	Error	61	.130		
n	9	16	20	20					
Breadth across the upper molars									
Mean	9.86	9.76	9.98	9.73	Area	1	.028	.32	.573
SD	.24	.32	.25	.34	Sex	1	.446	5.04	.028
SE	.08	.08	.06	.08	A × S	1	.083	.94	.337
CV	2.43	3.29	2.51	3.49	Error	61	.089		
n	9	16	20	20					
Breadth across the upper canines									
Mean	6.88	7.21	7.27	6.75	Area	1	.018	.42	.518
SD	.15	.22	.21	.22	Sex	1	.126	2.94	.092
SE	.05	.05	.05	.05	A × S	1	2.670	62.52	<.001
CV	2.18	3.05	2.89	3.26	Error	61	.043		
n	9	16	20	20					
Length of the maxillary toothrow									
Mean	9.53	9.53	9.69	9.37	Area	1	.000	.01	.922
SD	.19	.18	.15	.22	Sex	1	.391	11.16	.001
SE	.06	.04	.03	.05	A × S	1	.381	10.87	002
CV	1.99	1.89	1.55	2.35	Error	61	.035		
n	9	16	20	20					
Length of the upper molariform toothrow									
Mean	7.59	7.43	7.60	7.47	Area	1	.009	.24	.624
SD	.16	.23	.17	.20	Sex	1	.302	8.07	.006
SE	.05	.06	.04	.04	A × S	1	.003	.07	.786
CV	2.11	3.10	2.24	2.68	Error	61	.038		
n	9	16	20	20					

Table 10.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Width of the widest molar				
Mean	2.12	2.06	2.13	2.08	Area	1	.001	.08	.781
SD	.11	.14	.09	.08	Sex	1	.044	4.02	.050
SE	.04	.04	.02	.02	A × S	1	.000	.03	.860
CV	5.19	6.80	4.23	3.85	Error	61	.011		
n	9	16	20	20					
					Greatest length of the mandible				
Mean	19.31	19.30	19.43	18.76	Area	1	.648	3.82	.055
SD	.38	.39	.40	.45	Sex	1	1.696	9.98	.003
SE	.13	.10	.09	.10	A × S	1	1.587	9.34	.003
CV	1.97	2.02	2.06	2.40	Error	61	.170		
n	9	16	20	20					
					Length of the mandibular toothrow				
Mean	10.34	10.59	10.75	10.39	Area	1	.142	1.98	.165
SD	.27	.29	.31	.19	Sex	1	.049	.68	.412
SE	.09	.07	.07	.04	A × S	1	1.379	19.27	<.001
CV	2.61	2.74	2.88	1.83	Error	61	.072		
n	9	16	20	20					
					Length of the coronoid process				
Mean	6.38	6.74	7.03	6.79	Area	1	1.789	16.44	<.001
SD	.29	.29	.34	.37	Sex	1	.048	.44	.509
SE	.10	.07	.08	.08	A × S	1	1.337	12.28	<.001
CV	4.55	4.30	4.84	5.45	Error	61	.109		
n	9	16	20	20					

of the upper molariform tooth row, width of the widest molar, and greatest length of the maxilla) exhibit statistically significant secondary sexual variation. In the only case where females have a larger sample mean values than males (total length), statistical significance is not observed.

Clearly, when samples are from a restricted locality, as in the work of Taddei (1975*a*) or when geographic differences between sampling localities can be statistically controlled, as in the analyses for the Caatingas and Cerrado, strong sexual dimorphism has been detected by univariate analyses with males consistently larger than females. Perhaps the inclusion of specimens from disparate localities has confounded the results in the work of Valdez (1970). Similarly, the large morphometric heterogeneity attributable to geographic differences in the samples used by Power and Tamsitt (1973) may have prevented a simple set of unipolar size vectors from accounting for the differences between the sexes shown by discriminant function analysis.

Phyllostomus hastatus (Pallas, 1767)

P. h. hastatus is the presently recognized subspecies designation for populations of this species in the Northeast of Brazil (Jones and Carter, 1976). This large omnivore was rare in the Caatingas but widespread and common in both Cerrado and Cerradão habitats on the Chapada do Araripe. A colony of more than 100 individuals roosted in a small attic-like space (6 m by .5 m by .5 m) in the entrance arch to the Colégio Agrícola de Crato; the roost was also occupied by a larger colony of *Molossus molossus* (>300 individuals). Of the 108 individuals of *P. h. hastatus* eventually captured from the roost, 48 were males. This strongly suggests an equal sex ratio (Binomial Test, $P > .05$) and the absence of harem groups within the colony (contrary to the situation reported by Bradbury, 1977).

Swanepoel and Genoways (1979) cite authors who have published morphometric data on *P. hastatus*. G. M. Allen (1908), Lima (1926), Cunha Vieira (1942), and Taddei (1975*a*) are the only workers who have included Brazilian specimens in their accounts. The work of Taddei (1975*a*) is unique because he performed statistical analyses on large samples. He detected statistically significant secondary sexual variation in all 17 of the cranial characters examined and for eight of the 17 external characters. Males are larger on the average than females in all cases. The results from the Northeast of Brazil are comparable (Table 11). Males have larger sample means than females for all but two of the 30 variables. Statistically significant secondary sexual variation is detected in 15 of the 16 cranial characters and in eight of the 14 external characters. Clearly, *P. hastatus* is dimorphic with males larger than females.

Trachops cirrhosus (Spix, 1823)

Of the three nominal subspecies currently in use, *T. c. cirrhosus* is the appellation appropriate for Northeast Brazilian populations of this omnivore because its type locality is in Pernambuco (Jones and Carter, 1976). The distribution of *T. c. cirrhosus* in the Caatingas was restricted to serrotes or areas containing rock outcroppings and it was absent from both Cerrado and Cerradão habitats on the Chapada do Araripe. Sixteen of 35 individuals captured from the Caatingas were males, hence the sex ratio appears to be equal (Binomial Test, $P > .05$).

Peters (1865), Lima (1926), Cunha Vieira (1942), and Felten (1956) are the only authors among the group cited by Swanepoel and Genoways (1979) to include measurements of *T. cirrhosus* from Brazil. Information concerning individual variation is conspicuously absent from the literature and secondary sexual variation has not been examined in this species. The results of a statistical analysis of individual and secondary sexual variation for *T. c. cirrhosus* are given in Table 12. Only a single character exhibits statistically significant secondary sexual variation (breadth across the upper canines). Males have larger sample means than females for all of the cranial characters and four of the external characters while females have larger sample means than males for 10 external characters. Because of the relatively large sample sizes, low levels of significance associated with the analyses of variance and minor differences encountered between male and female mean values, it seems prudent to suggest that *T. cirrhosus* does not exhibit sexual dimorphism.

Subfamily Glossophaginae

Glossophaga soricina (Pallas, 1766)

This nectarivore was abundant and ubiquitous in Cerrado, Cerradão, and most habitats of the Caatingas; it is particularly dominant in disturbed or second growth areas. Abandoned man-made structures and caves were preferred roosting sites and colony size may exceed 2,000 individuals. Aggregations of *Carollia perspicillata* containing up to 20 individuals were frequently found roosting in association with *G. soricina* throughout the Northeast. Small groups of bats were frequently observed foraging near fruiting plants. *Solanum psniculatum* was the predominant fruit in the diet of Caatingas specimens whereas the fruit of *Vismia* was preferred in the Cerrado (although *Solanum* was also consumed). Males and females occurred in statistically indistinguishable proportions in the Caatingas (Binomial Test, $P > .05$); 46% of the 421 captured adult specimens were males. On the Chapada do Araripe, 56% of the 494 captured adult specimens were males. Although the proportion of males and females did differ significantly (Binomial Test, $P < .01$), the magnitude of the difference was small and probably reflects the vagaries of sampling by mist net rather than characteristics of the social structure in this species.

In the Caatingas, some sexual segregation occurred within the large roosts that occurred in abandoned buildings. Females tended to congregate as a central unit; males occupied more dispersed solitary locations at the periphery of the roost. This phenomenon became particularly evident as the time of parturition approached.

Of the four generally recognized subspecies, *Glossophaga s. soricina* is the designation applied to Brazilian specimens (Jones and Carter, 1976). Many authors report morphometric data on *G. soricina* (see Swanepoel and Genoways, 1979), but only Miller (1913), Lima (1926), Cunha Vieira (1942), and Taddei (1975*b*) include specimens from Brazil. Taddei (1975*b*) is unique among these authors in working with large samples of *G. soricina* and performing statistical analyses on numerous morphometric characters. He finds statistically significant sexual dimorphism in four of 17 external characters (head-body length, forearm length, length of the fifth metacarpal and length of the fourth metacarpal); in all four cases males were larger, on the average, than females. Among the 15 cranial characters analyzed, statistically significant secondary sexual variation is apparent in seven characters (length of molar, mandibular toothrow length, breadth across the canines, zygomatic breadth, braincase breadth, mastoid breadth, and depth of the cranium); females are larger on the average for the first two characters while males are larger on the average for the latter five characters.

The results of statistical analyses on the specimens of *G. s. soricina* from the Northeast of Brazil are

Table 11.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Phyllostomus hastatus *males and females from both the Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant (P < 0.50) secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Total length				
Mean	123.00	119.43	127.25	119.75	Sex	1	643.527	34.46	<.001
SD	—	1.81	4.19	5.07	Within	46	18.673		
SE	—	.69	.94	1.13					
CV	—	1.52	3.29	4.23					
n	1	7	20	20					
					Tail length				
Mean	19.00	17.86	19.15	18.50	Sex	1	7.741	1.60	.212
SD	—	2.04	1.93	2.57	Within	46	4.839		
SE	—	.77	.43	.57					
CV	—	11.42	10.08	13.89					
n	1	7	20	20					
					Hindfoot length				
Mean	17.00	17.57	17.75	17.05	Sex	1	3.307	2.80	.101
SD	—	.98	1.07	1.15	Within	46	1.182		
SE	—	.37	.24	.26					
CV	—	5.58	6.03	6.74					
n	1	7	20	20					
					Ear length				
Mean	28.00	28.14	28.90	27.75	Sex	1	11.938	7.23	.010
SD	—	1.57	.97	1.48	Within	46	1.652		
SE	—	.60	.22	.33					
CV	—	5.58	3.36	5.33					
n	1	7	20	20					
					Tragus length				
Mean	13.00	13.08	13.20	13.20	Sex	1	.021	.06	.810
SD	—	.58	.62	.62	Within	46	.062		
SE	—	.22	.14	.14					
CV	—	4.46	4.70	4.70					
n	1	7	20	20					
					Forearm length				
Mean	81.00	81.29	84.30	81.55	Sex	1	83.667	20.33	<.001
SD	—	2.50	1.63	2.19	Within	46	4.116		
SE	—	.94	.36	.49					
CV	—	3.08	1.93	2.69					
n	1	7	20	20					
					Weight				
Mean	94.50	84.64	93.43	81.68	Sex	1	1,437.574	21.46	<.001
SD	—	8.94	8.58	7.80	Within	46	66.987		
SE	—	3.38	1.92	1.74					
CV	—	10.56	9.18	9.55					
n	1	7	20	20					
					Length of digit one				
Mean	13.00	14.14	14.05	14.25	Sex	1	.583	.55	.462
SD	—	1.07	1.28	.72	Within	46	1.058		
SE	—	.40	.29	.16					
CV	—	7.57	9.11	5.05					
n	1	7	20	20					

Table 11.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	145.00	145.86	147.35	143.95	Sex	1	92.191	5.64	.022
SD	—	3.80	3.42	4.86	Within	46	16.358		
SE	—	1.16	.77	1.09					
CV	—	2.11	2.32	3.38					
n	1	7	20	20					
Length of digit four									
Mean	108.00	108.00	110.70	107.85	Sex	1	85.003	5.60	.022
SD	—	1.83	3.91	4.48	Within	46	15.170		
SE	—	.69	.87	1.00					
CV	—	1.69	3.53	4.15					
n	1	7	20	20					
Length of digit five									
Mean	98.00	99.14	102.15	98.15	Sex	1	148.446	14.42	<.001
SD	—	1.68	3.20	3.65	Within	46	10.293		
SE	—	.63	.69	.82					
CV	—	1.69	3.03	3.72					
n	1	7	20	20					
Tibia length									
Mean	32.00	32.57	33.65	32.75	Sex	1	8.894	10.03	.003
SD	—	.54	.67	1.21	Within	46	.886		
SE	—	.20	.15	.27					
CV	—	1.66	1.99	3.69					
n	1	7	20	20					
Calcar length									
Mean	19.00	21.29	21.35	20.40	Sex	1	4.373	1.93	.171
SD	—	1.11	1.66	1.35	Within	46	2.263		
SE	—	.42	.37	.30					
CV	—	5.21	7.78	6.62					
n	1	7	20	20					
Noseleaf length									
Mean	9.00	9.14	8.95	9.30	Sex	1	1.112	3.62	.063
SD	—	.38	.39	.73	Within	46	.307		
SE	—	.14	.09	.16					
CV	—	4.16	4.36	7.85					
n	1	7	20	20					
Greatest length of skull									
Mean	36.20	35.04	36.93	35.29	Sex	1	32.917	63.35	<.001
SD	—	.26	.96	.51	Within	46	.520		
SE	—	.10	.21	.12					
CV	—	.74	2.60	1.45					
n	1	7	20	20					
Condylobasal length									
Mean	32.20	31.16	32.70	31.16	Sex	1	27.011	92.12	<.001
SD	—	.38	.65	.48	Within	46	.293		
SE	—	.14	.15	.11					
CV	—	1.22	1.99	1.54					
n	1	7	20	20					
Zygomatic breadth									
Mean	20.90	19.54	20.93	19.70	Sex	1	19.000	68.79	<.001
SD	—	.47	.67	.39	Within	46	.276		
SE	—	.18	.15	.09					
CV	—	2.41	3.20	1.98					
n	1	7	20	20					

Table 11.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	6.80	6.66	7.03	6.83	Sex	1	.620	15.01	<.001
SD	—	.19	.23	.16	Within	46	.041		
SE	—	.07	.05	.04					
CV	—	2.85	3.27	2.34					
n	1	7	20	20					
Mastoid breadth									
Mean	19.30	18.14	19.46	18.00	Sex	1	23.627	145.84	<.001
SD	—	.28	.51	.32	Within	46	.162		
SE	—	.10	.11	.07					
CV	—	1.54	2.62	1.78					
n	1	7	20	20					
Breadth of braincase									
Mean	14.00	13.59	14.04	13.63	Sex	1	2.080	28.22	<.001
SD	—	.11	.29	.30	Within	46	.074		
SE	—	.04	.07	.07					
CV	—	.81	2.07	2.20					
n	1	7	20	20					
Rostral breadth									
Mean	9.50	9.09	9.65	9.14	Sex	1	3.099	56.09	<.001
SD	—	.23	.25	.24	Within	46	.055		
SE	—	.09	.06	.05					
CV	—	2.53	2.59	2.63					
n	1	7	20	20					
Height of braincase									
Mean	16.70	16.11	17.11	16.15	Sex	1	10.631	48.38	<.001
SD	—	.27	.62	.34	Within	46	.220		
SE	—	.10	.14	.08					
CV	—	1.68	3.62	2.11					
n	1	7	20	20					
Breadth across the upper molars									
Mean	13.00	12.86	13.56	13.22	Sex	1	1.997	23.00	<.001
SD	—	.31	.24	.27	Within	46	.087		
SE	—	.12	.05	.06					
CV	—	2.41	1.77	2.04					
n	1	7	20	20					
Breadth across the upper canines									
Mean	9.30	8.67	9.75	9.01	Sex	1	7.590	121.03	<.001
SD	—	.18	.23	.21	Within	46	.063		
SE	—	.07	.05	.05					
CV	—	2.08	2.36	2.33					
n	1	7	20	20					
Length of the maxillary toothrow									
Mean	13.10	12.70	13.33	12.81	Sex	1	3.414	54.65	<.001
SD	—	.33	.28	.19	Within	46	.063		
SE	—	.12	.06	.04					
CV	—	2.60	2.10	1.58					
n	1	7	20	20					
Length of the upper molariform toothrow									
Mean	10.20	9.83	10.09	9.91	Sex	1	.480	12.24	<.001
SD	—	.24	.21	.17	Within	46	.039		
SE	—	.09	.05	.04					
CV	—	2.44	2.08	1.72					
n	1	7	20	20					

Table 11.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Width of the widest molar				
Mean	3.30	3.41	3.43	3.32	Sex	1	.066	3.52	.067
SD	—	.19	.15	.10	Within	46	.019		
SE	—	.07	.03	.02					
CV	—	7.48	4.37	3.01					
n	1	7	20	20					
					Greatest length of the mandible				
Mean	24.90	24.11	25.50	24.16	Sex	1	20.801	90.70	<.001
SD	—	.27	.55	.46	Within	46	.229		
SE	—	.10	.12	.10					
CV	—	1.12	2.16	1.90					
n	1	7	20	20					
					Length of the mandibular toothrow				
Mean	14.80	14.14	15.23	14.47	Sex	1	8.027	84.45	<.001
SD	—	.35	.30	.26	Within	46	.095		
SE	—	.13	.07	.06					
CV	—	2.48	1.96	1.80					
n	1	7	20	20					
					Length of the coronoid process				
Mean	10.70	9.86	11.13	10.31	Sex	1	9.932	68.63	<.001
SD	—	.26	.44	.27	Within	46	.145		
SE	—	.10	.10	.06					
CV	—	2.64	3.95	2.62					
n	1	7	20	20					

Table 12.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Trachops cirrhosus *males and females from the Caatinga biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Total length				
Mean	100.81	98.58			Sex	1	43.331	.70	.409
SD	7.63	8.07			Within	33	61.972		
SE	1.91	1.85							
CV	7.57	8.19							
n	16	19							
					Tail length				
Mean	15.75	15.63			Sex	1	.122	.03	.875
SD	2.32	2.09			Within	33	4.831		
SE	.58	.48							
CV	14.73	13.37							
n	16	19							
					Hindfoot length				
Mean	16.25	16.26			Sex	1	.002	.00	.963
SD	.68	.93			Within	33	.687		
SE	.17	.21							
CV	4.18	5.72							
n	16	19							

Table 12.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Ear length				
Mean	32.31	33.58			Sex	1	.617	.17	.681
SD	2.02	1.77			Within	33	3.578		
SE	.51	.41							
CV	6.25	5.27							
n	16	19							
					Tragus length				
Mean	13.31	13.58			Sex	1	.617	.72	.401
SD	.95	.90			Within	33	.851		
SE	.24	.21							
CV	7.14	6.63							
n	16	19							
					Forearm length				
Mean	60.94	61.21			Sex	1	.648	.27	.604
SD	1.29	1.72			Within	33	2.367		
SE	.32	.39							
CV	2.12	2.81							
n	16	19							
					Weight				
Mean	38.88	39.16			Sex	1	.695	.02	.898
SD	4.46	7.68			Within	33	41.221		
SE	1.12	1.76							
CV	11.47	19.61							
n	16	19							
					Length of digit one				
Mean	14.19	14.95			Sex	1	.001	.00	.975
SD	.77	1.03			Within	33	.845		
SE	.19	.24							
CV	5.15	6.89							
n	16	19							
					Length of digit three				
Mean	115.50	115.58			Sex	1	.054	.00	.951
SD	3.16	4.18			Within	33	14.080		
SE	.79	.96							
CV	2.74	3.62							
n	16	19							
					Length of digit four				
Mean	85.06	85.68			Sex	1	3.357	.44	.511
SD	2.57	2.91			Within	33	7.607		
SE	.64	.67							
CV	3.02	3.40							
n	16	19							
					Length of digit five				
Mean	86.13	87.00			Sex	1	6.650	.78	.382
SD	2.75	3.04			Within	33	8.477		
SE	.69	.70							
CV	3.19	3.49							
n	16	19							
					Tibia length				
Mean	28.13	28.00			Sex	1	.136	.05	.821
SD	.81	2.06			Within	33	2.599		
SE	.20	.47							
CV	2.88	7.36							
n	16	19							

Table 12.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Calcar length				
Mean	13.81	13.95			Sex	1	.158	.11	.742
SD	.91	1.39			Within	33	1.436		
SE	.23	.32							
CV	6.59	9.96							
n	16	19							
					Noseleaf length				
Mean	8.25	8.00			Sex	1	.543	.94	.339
SD	.68	.82			Within	33	.576		
SE	.17	.19							
CV	8.24	10.25							
n	16	19							
					Greatest length of skull				
Mean	28.11	27.94			Sex	1	.261	.14	.715
SD	.69	.73			Within	32	.506		
SE	.18	.17							
CV	2.45	2.61							
n	15	19							
					Condylobasal length				
Mean	25.05	24.78			Sex	1	.631	2.14	.153
SD	.51	.57			Within	32	.295		
SE	.13	.13							
CV	2.04	2.30							
n	15	19							
					Zygomatic breadth				
Mean	14.46	14.34			Sex	1	.117	.41	.525
SD	.52	.53			Within	32	.283		
SE	.14	.12							
CV	3.66	3.70							
n	15	19							
					Postorbital constriction				
Mean	13.79	13.63			Sex	1	.202	1.73	.198
SD	.29	.38			Within	32	.117		
SE	.07	.09							
CV	2.10	2.79							
n	15	19							
					Mastoid breadth				
Mean	5.29	5.28			Sex	1	.000	.00	.968
SD	.13	.21			Within	32	.031		
SE	.03	.05							
CV	2.46	3.98							
n	15	19							
					Breadth of braincase				
Mean	11.77	11.63			Sex	1	.165	2.80	.104
SD	.27	.22			Within	32	.059		
SE	.07	.05							
CV	2.29	1.89							
n	15	19							
					Rostral breadth				
Mean	6.16	6.03			Sex	1	.138	2.88	.100
SD	.26	.18			Within	32	.048		
SE	.07	.04							
CV	4.22	2.99							
n	15	19							

Table 12.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Height of braincase									
Mean	14.73	14.61			Sex	1	.113	.72	.403
SD	.45	.35			Within	32	.157		
SE	.12	.08							
CV	3.05	2.40							
n	15	19							
Breadth across the upper molars									
Mean	10.37	10.30			Sex	1	.045	.41	.525
SD	.39	.28			Within	32	.109		
SE	.10	.06							
CV	3.76	2.72							
n	15	19							
Breadth across the upper canines									
Mean	6.18	6.07			Sex	1	.095	5.45	.026
SD	.12	.14			Within	31	.017		
SE	.03	.03							
CV	1.94	2.31							
n	15	18							
Length of the maxillary toothrow									
Mean	10.35	10.27			Sex	1	.062	1.04	.316
SD	.28	.21			Within	31	.059		
SE	.07	.05							
CV	2.71	2.04							
n	15	18							
Length of the upper molariform toothrow									
Mean	8.30	8.30			Sex	1	.000	.01	.943
SD	.27	.16			Within	32	.045		
SE	.07	.04							
CV	3.25	1.93							
n	15	19							
Width of the widest molar									
Mean	3.16	3.10			Sex	1	.030	1.87	.181
SD	.14	.12			Within	32	.016		
SE	.04	.03							
CV	4.43	3.87							
n	15	19							
Greatest length of the mandible									
Mean	18.90	18.63			Sex	1	.628	3.63	.066
SD	.42	.41			Within	32	.173		
SE	.11	.09							
CV	2.22	2.20							
n	15	19							
Length of the mandibular toothrow									
Mean	11.29	11.14			Sex	1	.188	3.07	.089
SD	.31	.18			Within	32	.061		
SE	.08	.04							
CV	2.75	1.62							
n	15	19							
Length of the coronoid process									
Mean	5.48	5.46			Sex	1	.002	.02	.877
SD	.34	.29			Within	32	.098		
SE	.09	.07							
CV	6.20	5.31							
n	15	19							

Table 13.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Glossophaga soricina *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean	63.90	63.90	63.30	64.75	Area	1	.313	.04	.837
SD	2.02	2.97	2.30	3.35	Sex	1	10.513	1.43	.236
SE	.45	.67	.51	.75	A × S	1	10.513	1.43	.236
CV	3.16	4.65	3.63	5.17	Error	76	7.363		
n	20	20	20	20					
				Tail length					
Mean	8.95	9.20	8.05	9.05	Area	1	5.513	3.67	.059
SD	1.10	1.20	1.28	1.32	Sex	1	7.813	5.21	.025
SE	.25	.26	.29	.29	A × S	1	2.813	1.87	.175
CV	12.29	13.04	15.90	14.59	Error	76	1.501		
n	20	20	20	20					
				Hindfoot length					
Mean	9.10	9.05	9.30	9.30	Area	1	1.013	2.83	.096
SD	.79	.39	.57	.57	Sex	1	.013	.03	.852
SE	.18	.09	.12	.12	A × S	1	.013	.03	.852
CV	8.68	4.31	6.13	6.13	Error	76	.357		
n	20	20	20	20					
				Ear length					
Mean	13.10	13.30	13.25	13.35	Area	1	.200	.26	.611
SD	1.25	.57	.72	.81	Sex	1	.450	.59	.446
SE	.28	.13	.16	.18	A × S	1	.050	.07	.799
CV	9.54	4.29	5.43	6.07	Error	76	.767		
n	20	20	20	20					
				Tragus length					
Mean	5.95	6.00	5.70	5.80	Area	1	1.013	2.71	.104
SD	.61	.46	.47	.83	Sex	1	.113	.30	.585
SE	.14	.10	.11	.19	A × S	1	.013	.03	.855
CV	10.25	7.67	8.25	14.31	Error	76	.373		
n	20	20	20	20					
				Forearm length					
Mean	35.15	36.10	35.05	35.75	Area	1	1.103	1.35	.249
SD	.88	.97	.83	.79	Sex	1	13.613	18.13	<.001
SE	.20	.22	.19	.18	A × S	1	.313	.42	.521
CV	2.50	2.69	2.37	2.21	Error	76	.751		
n	20	20	20	20					
				Weight					
Mean	9.40	10.50	10.18	10.63	Area	1	4.050	2.59	.112
SD	.45	1.48	.86	1.77	Sex	1	12.013	7.68	.007
SE	.10	.33	.19	.40	A × S	1	2.113	1.35	.249
CV	4.79	14.10	8.45	16.65	Error	76	1.564		
n	20	20	20	20					
				Length of digit one					
Mean	7.95	7.95	7.90	8.05	Area	1	.013	.04	.851
SD	.69	.69	.55	.39	Sex	1	.113	.32	.573
SE	.15	.15	.12	.09	A × S	1	.113	.32	.573
CV	8.68	8.68	6.96	4.84	Error	76	.351		
n	20	20	20	20					

Table 13.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of digit three					
Mean	68.55	69.40	69.00	69.70	Area	1	2.813	.72	.398
SD	1.91	2.31	1.69	2.06	Sex	1	12.013	3.08	.083
SE	.43	.49	.38	.46	A × S	1	.113	.03	.866
CV	2.79	3.18	2.45	2.96	Error	76	3.894		
n	20	20	20	20					
				Length of digit four					
Mean	50.70	51.75	50.30	51.20	Area	1	4.513	1.89	.173
SD	1.63	1.68	1.26	1.58	Sex	1	19.013	7.97	.006
SE	.36	.38	.28	.35	A × S	1	.113	.05	.829
CV	3.21	3.25	2.50	3.09	Error	76	2.386		
n	20	20	20	20					
				Length of digit five					
Mean	48.15	48.85	47.30	48.75	Area	1	4.513	2.21	.141
SD	1.50	1.50	1.03	1.62	Sex	1	23.113	11.33	.001
SE	.34	.34	.23	.36	A × S	1	2.813	1.38	.244
CV	3.12	3.07	2.18	3.32	Error	76	2.040		
n	20	20	20	20					
				Tibia length					
Mean	14.75	15.15	14.60	14.90	Area	1	.800	1.97	.165
SD	.79	.59	.60	.55	Sex	1	2.450	6.03	.016
SE	.18	.13	.13	.12	A × S	1	.050	.12	.727
CV	5.36	3.89	4.11	3.69	Error	76	.407		
n	20	20	20	20					
				Calcar length					
Mean	5.00	4.95	4.70	5.05	Area	1	.200	.76	.387
SD	.32	.61	.47	.61	Sex	1	.450	1.70	.196
SE	.07	.14	.11	.14	A × S	1	.800	3.02	.086
CV	6.40	12.32	10.00	12.08	Error	76	.265		
n	20	20	20	20					
				Noseleaf length					
Mean	4.05	4.10	3.80	4.00	Area	1	.613	3.34	.072
SD	.39	.55	.41	.32	Sex	1	.313	1.70	.196
SE	.09	.12	.09	.07	A × S	1	.113	.61	.436
CV	9.63	13.41	10.79	8.00	Error	76	.184		
n	20	20	20	20					
				Greatest length of skull					
Mean	20.45	20.54	20.29	20.53	Area	1	.136	1.07	.303
SD	.39	.31	.35	.36	Sex	1	.528	4.17	.045
SE	.09	.07	.08	.08	A × S	1	.105	.83	.365
CV	1.91	1.51	1.72	1.75	Error	76	.127		
n	20	20	20	20					
				Condylobasal length					
Mean	19.15	19.30	19.09	19.23	Area	1	.098	.85	.359
SD	.41	.26	.35	.32	Sex	1	.421	3.66	.060
SE	.09	.06	.08	.07	A × S	1	.001	.00	.948
CV	2.14	1.35	1.83	1.66	Error	76	.115		
n	20	20	20	20					
				Zygomatic breadth					
Mean	9.17	9.17	9.22	9.20	Area	1	.032	.90	.346
SD	.15	.16	.20	.23	Sex	1	.002	.06	.813
SE	.03	.04	.05	.05	A × S	1	.002	.06	.813
CV	3.06	1.74	2.17	2.50	Error	76	.036		
n	20	20	20	20					

Table 13.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Postorbital constriction				
Mean	4.58	4.60	4.63	4.69	Area	1	.078	2.72	.103
SD	.14	.15	.22	.15	Sex	1	.028	.98	.326
SE	.03	.03	.05	.03	A × S	1	.006	.21	.646
CV	3.06	3.26	4.75	3.20	Error	76	.029		
n	20	20	20	20					
					Mastoid breadth				
Mean	8.77	8.90	8.81	8.91	Area	1	.008	.25	.622
SD	.15	.13	.22	.20	Sex	1	.265	8.10	.006
SE	.03	.03	.05	.05	A × S	1	.005	.14	.712
CV	1.71	1.46	2.50	2.24	Error	76	.033		
n	20	20	20	20					
					Breadth of braincase				
Mean	8.64	8.64	8.56	8.72	Area	1	.000	.000	1.000
SD	.20	.23	.20	.24	Sex	1	.145	3.02	.086
SE	.04	.05	.05	.06	A × S	1	.128	2.68	.106
CV	2.31	2.66	2.34	2.75	Error	76	.048		
n	20	20	20	20					
					Rostral breadth				
Mean	3.82	3.82	3.83	3.87	Area	1	.015	.42	.517
SD	.17	.14	.21	.23	Sex	1	.006	.17	.680
SE	.04	.03	.05	.05	A × S	1	.006	.17	.680
CV	4.45	3.36	5.48	5.94	Error	76	.036		
n	20	20	20	20					
					Height of braincase				
Mean	9.28	9.11	9.16	9.17	Area	1	.021	.27	.607
SD	.34	.13	.22	.37	Sex	1	.136	1.72	.194
SE	.08	.03	.05	.08	A × S	1	.153	1.93	.169
CV	3.66	1.43	2.40	4.03	Error	76	.079		
n	20	20	20	20					
					Breadth across the upper molars				
Mean	5.33	5.33	5.34	5.33	Area	1	.000	.01	.936
SD	.12	.13	.15	.15	Sex	1	.001	.06	.810
SE	.03	.03	.03	.03	A × S	1	.001	.06	.810
CV	2.25	2.44	2.81	2.81	Error	76	.019		
n	20	20	20	20					
					Breadth across the upper canines				
Mean	3.96	3.87	3.93	3.94	Area	1	.004	.29	.591
SD	.11	.15	.10	.13	Sex	1	.032	2.07	.154
SE	.02	.03	.02	.03	A × S	1	.050	3.24	.076
CV	2.78	3.88	2.54	3.30	Error	76	.015		
n	20	20	20	20					
					Length of the maxillary toothrow				
Mean	6.99	7.04	6.97	7.04	Area	1	.002	.09	.770
SD	.19	.15	.15	.12	Sex	1	.072	3.11	.082
SE	.04	.03	.03	.03	A × S	1	.005	.19	.660
CV	2.72	2.13	2.15	1.70	Error	76	.023		
n	20	20	20	20					
					Length of the upper molariform toothrow				
Mean	5.34	5.23	5.26	5.25	Area	1	.013	.41	.523
SD	.21	.17	.16	.15	Sex	1	.072	2.38	.127
SE	.05	.04	.04	.03	A × S	1	.050	1.65	.203
CV	3.93	3.25	3.04	2.86	Error	76	.030		
n	20	20	20	20					

Table 13.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Width of the widest molar					
Mean	.97	.96	.97	.91	Area	1	.010	1.89	.173
SD	.07	.09	.06	.08	Sex	1	.028	5.26	.025
SE	.02	.02	.01	.02	A × S	1	.015	2.83	.097
CV	7.22	9.38	6.19	8.79	Error	76	.005		
n	20	20	20	20					
				Greatest length of the mandible					
Mean	13.79	13.89	13.73	13.87	Area	1	.032	.27	.604
SD	.27	.48	.33	.26	Sex	1	.245	2.24	.139
SE	.06	.11	.07	.06	A × S	1	.008	.07	.795
CV	1.96	3.46	2.40	1.87	Error	76	.118		
n	20	20	20	20					
				Length of the mandibular toothrow					
Mean	7.40	7.44	7.31	7.37	Area	1	.010	.32	.571
SD	.20	.26	.18	.13	Sex	1	.171	5.46	.022
SE	.04	.06	.04	.03	A × S	1	.001	.04	.850
CV	2.70	3.49	2.46	1.76	Error	76	.031		
n	20	20	20	20					
				Length of the coronoid process					
Mean	3.73	3.63	3.75	3.66	Area	1	.010	.32	.571
SD	.11	.18	.21	.19	Sex	1	.171	5.46	.022
SE	.03	.04	.05	.04	A × S	1	.001	.04	.850
CV	2.95	4.96	5.60	5.19	Error	76	.031		
n	20	20	20	20					

indicated in Table 13. Significant geographic differences between Caatingas and Cerrado sites are not apparent for any of the 30 analyzed variables, and a trend in average values between the sites is not obvious. Significant secondary sexual variation is indicated for six external characters (tail length, forearm length, weight, length of digit IV, length of digit V, and tibia length) and six cranial characters (greatest length of skull, condylobasal length, mastoid breadth, width of the widest molar, length from the canine to the last molar in the ramus, and length of the coronoid process). The sample means for females are larger than those for males for nine external characters and seven cranial characters while the sample means for males are larger than those for females for only two characters. Sexual dimorphism is more pronounced in Northeast Brazilian populations of *G. soricina* than in those from southwestern São Paulo. Further, the trend found in the Northeast of female sample means being consistently larger than male sample means is contrary to the results obtained by Taddei (1975*b*).

Lonchophylla mordax Thomas, 1903

Jones and Carter (1976) consider *L. mordax* to be a monotypic species, however, they note that it may be conspecific with *L. concava* as suggested by Handley (1966). This nectarivore was common in Caatingas habitats, especially at sites near serrotes. Because 51% of the 72 captured specimens were males, the sex ratio must be considered equal (Binomial Test, $P > .05$). *L. mordax* was apparently absent from the Chapada do Araripe.

Very little has been published on the morphometrics of *L. mordax* (see Swanepoel and Genoways, 1979) and nothing is known concerning individual variation or secondary sexual variation in this species. A statistical analysis of morphometric variation in a Caatingas population of *L. mordax* is presented in Table 14. Five external and four cranial characters exhibit statistically significant secondary sexual variation. It appears that secondary sexual variation in this species is related to skull shape rather than skull size and to the overall size of the wings, with females having larger wings than males on the average.

Anoura geoffroyi Gray, 1838

Three nominal subspecies of this nectarivore are recognized, with *A. g. geoffroyi* being the designation applied to Brazilian specimens (Jones and Carter, 1976). *A. g. geoffroyi* was uncommon in the

Table 14.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Lonchophylla mordax *males and females from the Caatinga biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	64.81	66.14			Sex	1	31.914	2.86	.095
SD	3.47	3.19			Within	70	11.142		
SE	.57	.54							
CV	5.35	4.82							
n	37	35							
Tail length									
Mean	10.05	10.17			Sex	1	.248	.15	.699
SD	1.37	1.18			Within	70	1.641		
SE	.23	.20							
CV	13.63	11.60							
n	37	35							
Hindfoot length									
Mean	9.03	9.20			Sex	1	.538	1.53	.220
SD	.65	.53			Within	70	.351		
SE	.11	.09							
CV	7.20	5.76							
n	37	35							
Ear length									
Mean	14.60	14.77			Sex	1	.562	.69	.409
SD	.93	.88			Within	70	.816		
SE	.15	.15							
CV	6.37	5.96							
n	37	35							
Tragus length									
Mean	6.00	5.97			Sex	1	.015	.04	.840
SD	.67	.51			Within	70	.357		
SE	.11	.09							
CV	11.17	8.54							
n	37	35							
Forearm length									
Mean	34.65	35.14			Sex	1	4.393	4.35	.041
SD	1.14	.85			Within	70	1.010		
SE	.19	.14							
CV	3.29	2.42							
n	37	35							
Weight									
Mean	8.32	8.87			Sex	1	5.384	8.14	.006
SD	.60	.99			Within	70	.661		
SE	.10	.17							
CV	7.21	11.16							
n	37	35							
Length of digit one									
Mean	7.68	7.54			Sex	1	.317	.97	.327
SD	.58	.56			Within	70	.326		
SE	.10	.10							
CV	7.55	7.43							
n	37	35							

Table 14.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	66.70	67.77			Sex	1	20.54	5.71	.020
SD	2.12	1.63			Within	70	3.60		
SE	.35	.28							
CV	3.18	2.41							
n	37	35							
Length of digit four									
Mean	49.43	50.23			Sex	1	11.400	6.58	.012
SD	1.24	1.40			Within	70	1.732		
SE	.20	.24							
CV	2.51	2.79							
n	37	35							
Length of digit five									
Mean	47.27	47.66			Sex	1	2.692	1.30	.259
SD	1.41	1.48			Within	70	2.074		
SE	.23	.25							
CV	2.98	3.11							
n	37	35							
Tibia length									
Mean	15.08	15.14			Sex	1	.069	.11	.739
SD	.68	.88			Within	70	.615		
SE	.11	.15							
CV	4.51	5.81							
n	37	35							
Calcar length									
Mean	5.57	5.86			Sex	1	1.508	4.52	.037
SD	.56	.60			Within	70	.334		
SE	.09	.10							
CV	10.05	10.24							
n	37	35							
Noseleaf length									
Mean	5.05	4.89			Sex	1	.510	1.84	.180
SD	.52	.53			Within	70	.278		
SE	.09	.09							
CV	10.30	10.84							
n	37	35							
Greatest length of skull									
Mean	22.58	22.59			Sex	1	.001	.00	.944
SD	.43	.37			Within	68	.161		
SE	.07	.07							
CV	1.90	1.64							
n	37	33							
Condylobasal length									
Mean	21.33	21.36			Sex	1	.012	.08	.784
SD	.46	.33			Within	67	.163		
SE	.08	.06							
CV	2.16	1.54							
n	36	33							

Table 14.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	4.22	4.30			Sex	1	.109	4.12	.046
SD	.13	.19			Within	69	.026		
SE	.02	.03							
CV	3.08	4.42							
n	37	34							
Mastoid breadth									
Mean	9.08	9.01			Sex	1	.068	1.79	.185
SD	.16	.23			Within	67	.038		
SE	.03	.04							
CV	1.76	2.55							
n	36	33							
Breadth of braincase									
Mean	8.39	8.31			Sex	1	.114	3.68	.059
SD	.19	.16			Within	69	.031		
SE	.03	.03							
CV	2.26	1.93							
n	37	34							
Rostral breadth									
Mean	3.62	3.53			Sex	1	.150	6.88	.011
SD	.16	.14			Within	69	.022		
SE	.03	.02							
CV	4.42	3.97							
n	37	34							
Height of braincase									
Mean	8.73	8.75			Sex	1	.002	.03	.871
SD	.26	.24			Within	59	.062		
SE	.05	.05							
CV	2.98	2.74							
n	32	29							
Breadth across the upper molars									
Mean	5.10	5.14			Sex	1	.024	.97	.328
SD	.16	.16			Within	57	.025		
SE	.03	.03							
CV	3.14	3.11							
n	32	27							
Breadth across the upper canines									
Mean	3.71	3.56			Sex	1	.314	14.57	<.001
SD	.15	.15			Within	58	.022		
SE	.03	.03							
CV	4.04	4.21							
n	32	28							
Length of the maxillary toothrow									
Mean	7.75	7.81			Sex	1	.049	1.10	.298
SD	.25	.16			Within	57	.045		
SE	.04	.03							
CV	3.23	2.05							
n	32	27							
Length of the upper molariform toothrow									
Mean	5.82	5.86			Sex	1	.028	1.01	.318
SD	.18	.15			Within	57	.028		
SE	.03	.03							
CV	3.09	2.56							
n	32	27							

Table 14.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Width of the widest molar					
Mean	.92	.96			Sex	1	.022	5.38	.024
SD	.07	.05			Within	58	.004		
SE	.01	.01							
CV	7.61	5.21							
n	32	28							
				Greatest length of the mandible					
Mean	15.71	15.78			Sex	1	.076	.53	.470
SD	.45	.29			Within	69	.145		
SE	.07	.05							
CV	3.86	1.84							
n	37	34							
				Length of the mandibular toothrow					
Mean	8.12	8.07			Sex	1	.033	.66	.419
SD	.20	.25			Within	59	.050		
SE	.04	.05							
CV	2.46	3.10							
n	32	29							
				Length of the coronoid process					
Mean	3.87	3.79			Sex	1	.110	2.38	.128
SD	.21	.22			Within	67	.050		
SE	.03	.04							
CV	5.43	5.80							
n	37	32							

Caatingas where it was usually associated with serrote habitats, but it was locally abundant in open areas of Cerradão or in Cerrado habitats on the Chapada do Araripe. In the Caatingas population, 44% of the 25 captured individuals were males, hence, the sexes occur in equal proportion (Binomial Test, $P > .05$). In contrast, only 21% of the 270 captured specimens in the Cerrado were males; this indicates that males and females occur in significantly different proportions (Binomial Test, $P < .01$) on the Chapada do Araripe.

Morphometric data are reported for Brazilian specimens of *A. g. geoffroyi* by Dobson (1878), Lima (1926), and Cunha Vieira (1942). More recently, Anderson (1957) was unable to detect statistically significant secondary sexual variation in large samples of males and females from Chiapas, Mexico. He did, however, find forearm length and skull length to be significantly different for specimens from South America and Chiapas.

Statistically significant secondary sexual variation in specimens from the Northeast of Brazil is evidenced by three external and five cranial characters; geographic variation between Caatingas and Cerrado habitats is statistically significant for two external and four cranial characters (Table 15).

Subfamily Carolliinae

Carollia perspicillata (Linnaeus, 1758)

This frugivore was abundant and ubiquitous in all habitats of the Caatingas and Cerrado; it was frequently found roosting in man-made structures in association with *Glossophaga soricina.* Of the three subspecies currently recognized, *C. p. perspicillata* is the designation applied to specimens from the Northeast of Brazil (Jones and Carter, 1976). Fruits of *Vismia* composed the major portion of this species' diet on the Chapada do Araripe. Of the 467 captured adult specimens from Cerrado and Cerradão habitats, 42% were males; the proportion of males and females were not statistically equal (Binomial Test, $P < .01$). Although significant, the magnitude of difference between males and females was small; this suggests that factors other than social structure (for example, increased catchability of less maneuverable pregnant females may inflate their

Table 15.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Anoura geoffroyi *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean	63.73	63.57	65.45	67.85	Area	1	137.287	23.85	<.001
SD	2.57	2.88	2.44	1.84	Sex	1	19.198	3.34	.073
SE	.78	.77	.55	.41	A × S	1	24.901	4.33	.042
CV	4.03	4.53	3.73	2.71	Error	61	5.756		
n	11	14	20	20					
				Hindfoot length					
Mean	10.27	10.79	10.80	10.55	Area	1	.324	.54	.466
SD	.65	.58	1.11	.51	Sex	1	.264	.44	.510
SE	.20	.16	.25	.11	A × S	1	2.219	3.69	.059
CV	6.33	5.38	10.28	4.83	Error	61	.602		
n	11	14	20	20					
				Ear length					
Mean	14.55	14.43	14.35	14.65	Area	1	.003	.00	.949
SD	1.04	1.02	.67	.49	Sex	1	.128	.21	.649
SE	.31	.27	.15	.11	A × S	1	.663	1.08	.302
CV	7.15	7.07	4.67	3.34	Error	61	.611		
n	11	14	20	20					
				Tragus length					
Mean	6.27	5.71	5.90	5.70	Area	1	.571	1.66	.203
SD	.65	.47	.64	.57	Sex	1	2.193	6.36	.014
SE	.20	.13	.14	.13	A × S	1	.490	1.42	.238
CV	10.37	8.23	10.85	10.00	Error	61	.345		
n	11	14	20	20					
				Forearm length					
Mean	42.82	42.14	42.80	43.00	Area	1	2.683	2.46	.122
SD	1.17	.54	1.06	1.21	Sex	1	.861	.79	.378
SE	.35	.14	.24	.27	A × S	1	2.921	2.68	.107
CV	2.73	1.28	2.48	2.81	Error	61	1.091		
n	11	14	20	20					
				Weight					
Mean	15.50	14.36	15.13	15.55	Area	1	2.550	2.07	.155
SD	1.14	1.34	1.00	1.03	Sex	1	1.964	1.60	.211
SE	.34	.36	.22	.23	A × S	1	9.370	7.61	.008
CV	7.35	9.33	6.61	6.62	Error	61	1.231		
n	11	14	20	20					
				Length of digit one					
Mean	8.00	7.93	8.45	8.15	Area	1	1.719	7.27	.009
SD	.45	.48	.51	.49	Sex	1	.526	2.22	.141
SE	.14	.13	.11	.11	A × S	1	.199	.84	.363
CV	5.63	6.05	6.04	6.01	Error	61	.237		
n	11	14	20	20					
				Length of digit three					
Mean	84.91	84.50	85.75	85.50	Area	1	12.918	1.68	.200
SD	4.23	1.99	2.63	2.37	Sex	1	1.656	.22	.644
SE	1.28	.53	.59	.53	A × S	1	.097	.01	.911
CV	4.98	2.36	3.07	2.77	Error	61	7.691		
n	11	14	20	20					

Table 15.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit four									
Mean	62.00	60.36	61.65	61.10	Area	1	.588	.17	.678
SD	1.84	1.74	2.01	1.71	Sex	1	18.330	5.44	.023
SE	.56	.46	.45	.38	A × S	1	4.553	1.35	.250
CV	2.97	2.88	3.26	2.80	Error	61	3.370		
n	11	14	20	20					
Length of digit five									
Mean	54.82	52.71	54.20	53.40	Area	1	.017	.00	.946
SD	1.54	1.94	2.44	1.57	Sex	1	32.144	8.43	.005
SE	.46	.52	.55	.35	A × S	1	6.481	1.70	.197
CV	2.81	3.68	4.50	2.94	Error	61	3.811		
n	11	14	20	20					
Tibia length									
Mean	16.64	16.21	16.55	16.65	Area	1	.465	.88	.353
SD	.67	.43	.89	.75	Sex	1	.395	.74	.392
SE	.20	.11	.20	.17	A × S	1	1.039	1.96	.167
CV	4.03	2.65	5.38	4.50	Error	61	.531		
n	11	14	20	20					
Calcar length									
Mean	3.27	3.21	3.10	2.95	Area	1	.728	2.30	.134
SD	.65	.70	.45	.51	Sex	1	.166	.52	.472
SE	.20	.19	.10	.11	A × S	1	.032	.10	.752
CV	19.88	21.81	14.52	17.29	Error	61	.316		
n	11	14	20	20					
Noseleaf length									
Mean	3.82	3.71	4.10	3.90	Area	1	.833	3.16	.081
SD	.60	.47	.55	.45	Sex	1	.352	1.33	.253
SE	.18	.13	.12	.10	A × S	1	.035	.13	.716
CV	15.71	12.67	13.41	11.54	Error	61	.264		
n	11	14	20	20					
Greatest length of skull									
Mean	24.76	24.34	24.95	24.83	Area	1	1.740	8.04	.006
SD	.43	.34	.62	.38	Sex	1	1.165	5.38	.024
SE	.13	.09	.14	.08	A × S	1	.350	1.62	.209
CV	1.74	1.40	2.48	1.53	Error	61	.217		
n	11	14	20	20					
Condylobasal length									
Mean	24.10	23.67	24.11	24.06	Area	1	.591	2.54	.116
SD	.39	.37	.64	.40	Sex	1	.891	3.84	.055
SE	.12	.10	.14	.09	A × S	1	.532	2.29	.136
CV	1.62	1.53	2.65	1.66	Error	61	.232		
n	11	14	20	20					
Zygomatic breadth									
Mean	10.85	10.83	10.94	10.86	Area	1	.031	.44	.513
SD	.35	.23	.26	.19	Sex	1	.019	.28	.602
SE	.12	.10	.07	.07	A × S	1	.083	.12	.732
CV	3.23	2.12	2.38	1.75	Error	32	.070		
n	8	6	14	8					

Table 15.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Postorbital constriction									
Mean	5.13	5.04	5.19	5.17	Area	1	.130	3.08	.085
SD	.16	.24	.23	.18	Sex	1	.038	.89	.349
SE	.05	.06	.05	.04	A × S	1	.018	.43	.513
CV	3.12	4.76	4.43	3.48	Error	61	.042		
n	11	14	20	20					
Mastoid breadth									
Mean	10.30	10.12	10.36	10.30	Area	1	.217	2.69	.106
SD	.26	.28	.28	.30	Sex	1	.217	2.69	.106
SE	.08	.08	.06	.07	A × S	1	.054	.67	.418
CV	2.52	2.77	2.70	2.91	Error	61	.081		
n	11	14	20	20					
Breadth of braincase									
Mean	9.71	9.61	9.78	9.80	Area	1	.255	5.20	.026
SD	.12	.24	.21	.26	Sex	1	.023	.46	.500
SE	.04	.06	.05	.06	A × S	1	.061	1.25	.268
CV	1.24	2.50	2.15	2.65	Error	61	.049		
n	11	14	20	20					
Rostral breadth									
Mean	4.28	4.14	4.31	4.16	Area	1	.009	.40	.532
SD	.17	.17	.13	.14	Sex	1	.323	14.86	<.001
SE	.05	.05	.03	.03	A × S	1	.000	.00	.988
CV	3.97	4.11	3.02	3.37	Error	61	.022		
n	11	14	20	20					
Height of braincase									
Mean	9.92	9.66	9.89	9.94	Area	1	.214	3.91	.053
SD	.14	.29	.23	.23	Sex	1	.156	2.86	.096
SE	.05	.08	.05	.05	A × S	1	.363	6.64	.013
CV	1.41	3.00	3.33	2.31	Error	61	.055		
n	9	14	20	20					
Breadth across the upper molars									
Mean	6.24	6.15	6.24	6.21	Area	1	.010	.30	.587
SD	.10	.16	.22	.19	Sex	1	.053	1.53	.221
SE	.03	.05	.05	.04	A × S	1	.019	.54	.465
CV	1.60	2.60	3.53	3.06	Error	58	.034		
n	9	13	20	20					
Breadth across the upper canines									
Mean	4.93	4.52	5.02	4.66	Area	1	.166	6.79	.102
SD	.16	.17	.16	.14	Sex	1	2.033	83.24	<.001
SE	.05	.05	.04	.03	A × S	1	.011	.43	.513
CV	3.25	3.76	3.19	3.00	Error	58	.024		
n	9	13	20	20					
Length of the maxillary toothrow									
Mean	9.41	9.19	9.44	9.39	Area	1	.183	2.76	.102
SD	.31	.19	.26	.27	Sex	1	.256	3.88	.054
SE	.11	.05	.06	.06	A × S	1	.114	1.73	.193
CV	3.29	2.07	2.75	2.88	Error	58	.066		
n	9	13	20	20					
Length of the upper molariform toothrow									
Mean	7.87	7.68	7.87	7.87	Area	1	.121	1.95	.168
SD	.27	.25	.24	.25	Sex	1	.125	2.02	.161
SE	.09	.07	.05	.06	A × S	1	.125	2.02	.161
CV	3.43	3.26	3.05	3.18	Error	58	.062		
n	9	13	20	20					

Table 15.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Width of the widest molar					
Mean	1.19	1.17	1.14	1.19	Area	1	.004	1.05	.309
SD	.06	.05	.06	.07	Sex	1	.002	.62	.436
SE	.02	.01	.01	.02	A × S	1	.015	4.01	.050
CV	5.04	4.27	5.26	5.88	Error	58	.004		
n	9	13	20	20					
				Greatest length of the mandible					
Mean	8.08	7.74	8.17	8.20	Area	1	1.113	8.34	.005
SD	.40	.32	.44	.29	Sex	1	.376	2.82	.099
SE	.12	.08	.10	.07	A × S	1	.505	3.78	.056
CV	4.95	4.13	5.39	3.54	Error	61	.134		
n	11	14	20	20					
				Length of the mandibular toothrow					
Mean	9.88	9.62	9.95	9.78	Area	1	.195	3.27	.076
SD	.28	.19	.23	.27	Sex	1	.649	10.90	.002
SE	.09	.05	.05	.06	A × S	1	.030	.50	.483
CV	2.83	1.98	2.31	2.76	Error	58	.060		
n	9	13	20	20					
				Length of the coronoid process					
Mean	4.38	3.92	4.34	4.13	Area	1	.094	1.93	.170
SD	.31	.18	.18	.23	Sex	1	1.713	35.27	<.001
SE	.09	.05	.04	.05	A × S	1	.239	4.92	.030
CV	7.08	4.60	4.15	5.67	Error	61	.049		
n	11	14	20	20					

sample frequency, resulting in unequal sex ratios in large samples) affect the observed proportion of the sexes. In the Caatingas, 47% of the 366 captured adult specimens were males; the sexes occurred in statistically equal frequency (Binomial Test, $P > .05$).

Although a great deal of information is available on the morphometric characteristics of *C. perspicillata* (see Swanepoel and Genoways, 1979), little has been published on specimens from Brazil. Hahn (1907), Cunha Vieira (1942), Pine (1972), Pirlot (1972), and Taddei (1975*b*) have reported measurements from Brazil, but only Taddei (1975*b*) has performed rigorous statistical analyses. He found that females are larger on the average than males when considering external characters, but statistically different for only four of the 17 characters (head-body length, ear length, forearm length, and length of metacarpal II). Conversely, on the average, males are larger than females when considering a group of 15 cranial characters, but only one character, mastoid breadth, is statistically significantly different. Tamsitt and Valdivieso (1963) state that males and females from Colombia do not differ in size, and that specimens on opposite sides of the Andes do not differ in any character.

Only two external characters (total length and weight) exhibit statistically significant sexual variation in specimens from Northeast Brazil, and no trend is apparent with regard to average size relationships between the sexes. However, when considering cranial characteristics, the sample means of males are generally larger than those of females and for six characters, statistically significant differences are detected (see Table 16). Caatingas specimens have larger sample means than Cerrado specimens for 11 of the 15 analyzed cranial characters; statistically significant differences are indicated for six characters (Table 16). Size trends for external characters are not apparent and only two characters (tragus length and weight) have statistically distinguishable means.

Subfamily Stenodermatinae

Sturnira lilium (E. Geoffroy, 1810)

Of the six tentatively recognized subspecies, *S. l. lilium* is the designation properly applied to specimens from the Northeast of Brazil (Jones and Car-

Table 16.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Carollia perspicillata *males and femlaes from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	72.80	75.65	71.95	73.45	Area	1	46.513	3.49	.066
SD	3.76	4.02	2.80	3.90	Sex	1	94.613	7.09	.009
SE	.84	.90	.63	.87	A × S	1	9.113	.68	.411
CV	5.16	5.31	3.89	5.31	Error	76	13.338		
n	20	20	20	20					
Tail length									
Mean	10.70	11.05	10.75	11.30	Area	1	.450	.15	.700
SD	1.92	1.85	1.68	1.46	Sex	1	4.050	1.34	.250
SE	.43	.41	.38	.33	A × S	1	.200	.07	.797
CV	17.94	16.74	15.63	12.92	Error	76	3.015		
n	20	20	20	20					
Hindfoot length									
Mean	11.85	11.65	11.60	11.75	Area	1	.113	.15	.701
SD	.88	.59	1.05	.91	Sex	1	.013	.02	.898
SE	.20	.13	.23	.20	A × S	1	.613	.81	.372
CV	7.43	5.06	9.05	7.74	Error	76	.759		
n	20	20	20	20					
Ear length									
Mean	19.55	19.30	19.00	19.15	Area	1	2.450	2.46	.121
SD	1.10	1.03	1.03	.81	Sex	1	.050	.05	.823
SE	.25	.23	.23	.18	A × S	1	.800	.80	.373
CV	5.63	5.34	5.42	4.23	Error	76	.996		
n	20	20	20	20					
Tragus length									
Mean	7.70	7.90	8.35	8.30	Area	1	5.513	13.62	<.001
SD	.66	.64	.49	.73	Sex	1	.113	.28	.600
SE	.15	.14	.11	.16	A × S	1	.313	.77	.382
CV	8.57	8.10	5.87	8.80	Error	76	.405		
n	20	20	20	20					
Forearm length									
Mean	42.70	42.95	42.25	42.70	Area	1	2.450	1.11	.295
SD	1.87	1.10	1.37	1.49	Sex	1	2.450	1.11	.295
SE	.42	.25	.31	.33	A × S	1	.200	.09	.764
CV	4.38	2.56	3.24	3.49	Error	76			
n	20	20	20	20					
Weight									
Mean	18.72	20.88	18.50	18.70	Area	1	28.561	6.02	.016
SD	1.35	3.30	1.33	2.11	Sex	1	27.848	5.87	.018
SE	.30	.74	.30	.47	A × S	1	19.208	4.05	.048
CV	7.21	15.80	7.19	11.28	Error	76	4.742		
n	20	20	20	20					
Length of digit one									
Mean	10.85	10.95	11.10	11.30	Area	1	1.800	4.97	.029
SD	.49	.69	.64	.57	Sex	1	.450	1.24	.268
SE	.11	.15	.14	.13	A × S	1	.050	.14	.711
CV	4.52	6.30	5.77	5.04	Error	76	.362		
n	20	20	20	20					

Table 16.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Length of digit three				
Mean	89.60	90.80	89.65	90.50	Area	1	.313	.03	.860
SD	3.24	2.93	3.63	2.78	Sex	1	21.013	2.10	.151
SE	.72	.66	.81	.62	A × S	1	.613	.06	.805
CV	3.62	3.23	4.05	3.07	Error	76	9.994		
n	20	20	20	20					
					Length of digit four				
Mean	65.35	65.50	65.50	65.50	Area	1	.113	.03	.860
SD	1.69	1.85	2.07	1.93	Sex	1	.113	.03	.860
SE	.38	.41	.46	.43	A × S	1	.113	.03	.860
CV	2.59	2.82	3.16	2.95	Error	76	3.573		
n	20	20	20	20					
					Length of digit five				
Mean	64.50	64.30	64.00	64.95	Area	1	.113	.03	.871
SD	1.73	2.08	2.56	1.79	Sex	1	2.813	.66	.419
SE	.39	.47	.57	.40	A × S	1	6.613	1.55	.217
CV	2.68	3.23	4.00	2.76	Error	76	4.265		
n	20	20	20	20					
					Tibia length				
Mean	19.80	19.60	19.70	19.60	Area	1	.050	.04	.851
SD	.83	.82	1.38	1.54	Sex	1	.450	.32	.574
SE	.19	.19	.31	.34	A × S	1	.050	.04	.851
CV	4.19	4.18	7.01	7.86	Error	76	1.408		
n	20	20	20	20					
					Calcar length				
Mean	7.70	7.95	7.50	8.15	Area	1	.000	.000	1.000
SD	.87	1.23	.89	1.04	Sex	1	4.050	3.91	.052
SE	.19	.28	.20	.23	A × S	1	.800	.77	.382
CV	11.30	15.47	11.87	12.76	Error	76	1.036		
n	20	20	20	20					
					Noseleaf length				
Mean	6.60	6.65	6.45	6.40	Area	1	.800	1.73	.192
SD	.75	.75	.61	.60	Sex	1	.000	.000	1.000
SE	.17	.17	.14	.13	A × S	1	.050	.11	.743
CV	11.36	11.28	9.46	9.38	Error	76	.462		
n	20	20	20	20					
					Greatest length of skull				
Mean	22.26	22.00	22.10	21.77	Area	1	.722	3.99	.049
SD	.43	.28	.45	.52	Sex	1	1.741	9.61	.003
SE	.10	.06	.10	.12	A × S	1	.025	.14	.714
CV	1.93	1.27	2.04	2.39	Error	76	.181		
n	20	20	20	20					
					Condylobasal length				
Mean	20.23	20.03	20.05	19.81	Area	1	.780	4.33	.041
SD	.46	.36	.35	.51	Sex	1	.946	5.25	.025
SE	.10	.08	.08	.11	A × S	1	.010	.06	.813
CV	2.27	1.80	1.75	2.57	Error	76	.180		
n	20	20	20	20					
					Postorbital constriction				
Mean	5.68	5.55	5.63	5.51	Area	1	.037	.79	.376
SD	.19	.20	.18	.27	Sex	1	.300	6.59	.012
SE	.04	.05	.04	.06	A × S	1	.001	.02	.876
CV	3.35	3.60	3.20	4.90	Error	76	.046		
n	20	20	20	20					

Table 16.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Mastoid breadth				
Mean	10.87	10.86	10.97	10.83	Area	1	.025	.25	.616
SD	.38	.30	.31	.24	Sex	1	.113	1.16	.285
SE	.09	.07	.07	.05	A × S	1	.072	.74	.391
CV	3.50	2.76	2.83	2.22	Error	76	.097		
n	20	20	20	20					
					Breadth of braincase				
Mean	9.75	9.65	9.75	9.73	Area	1	.032	.51	.477
SD	.21	.31	.25	.22	Sex	1	.072	1.15	.287
SE	.05	.07	.06	.05	A × S	1	.032	.51	.477
CV	2.15	3.21	2.56	2.26	Error	76	.063		
n	20	20	20	20					
					Rostral breadth				
Mean	5.19	5.03	5.05	4.94	Area	1	.276	8.21	.005
SD	.17	.21	.19	.16	Sex	1	.351	10.43	.002
SE	.04	.05	.04	.04	A × S	1	.015	.45	.505
CV	3.28	4.17	3.76	3.24	Error	76	.034		
n	20	20	20	20					
					Height of braincase				
Mean	10.87	10.89	10.84	10.85	Area	1	.021	.27	.605
SD	.30	.18	.37	.23	Sex	1	.003	.04	.842
SE	.07	.04	.08	.05	A × S	1	.000	.00	.968
CV	2.76	1.65	3.41	2.12	Error	76	.079		
n	20	20	20	20					
					Breadth across the upper molars				
Mean	3.02	8.07	7.95	7.89	Area	1	.288	5.39	.023
SD	.24	.25	.18	.25	Sex	1	.001	.01	.923
SE	.05	.06	.04	.06	A × S	1	.061	1.13	.291
CV	2.99	3.10	2.26	3.17	Error	76	.053		
n	20	20	20	20					
					Breadth across the upper canines				
Mean	5.30	5.03	5.17	4.98	Area	1	.171	6.44	.013
SD	.18	.13	.16	.17	Sex	1	.035	38.95	<.001
SE	.04	.03	.04	.04	A × S	1	.036	1.36	.247
CV	3.40	2.58	3.09	3.41	Error	76	.027		
n	20	20	20	20					
					Length of the maxillary toothrow				
Mean	7.61	7.54	7.53	7.47	Area	1	.113	2.28	.135
SD	.34	.14	.15	.20	Sex	1	.085	1.71	.194
SE	.08	.03	.03	.05	A × S	1	.000	.000	1.000
CV	4.47	1.86	1.99	2.68	Error	76	.049		
n	20	20	20	20					
					Length of the upper molariform toothrow				
Mean	5.97	5.93	5.79	5.93	Area	1	.162	3.09	.083
SD	.20	.17	.33	.19	Sex	1	.050	.95	.332
SE	.05	.04	.07	.04	A × S	1	.162	3.09	.083
CV	3.35	2.87	5.70	3.20	Error	76	.052		
n	20	20	20	20					
					Width of the widest molar				
Mean	1.61	1.56	1.53	1.54	Area	1	.050	5.47	.022
SD	.11	.09	.07	.10	Sex	1	.013	1.37	.246
SE	.02	.02	.02	.02	A × S	1	.018	1.97	.165
CV	6.83	5.77	4.58	6.49	Error	76	.009		
n	20	20	20	20					

Table 16.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Greatest length of the mandible					
Mean	14.78	14.71	14.73	14.53	Area	1	.253	1.73	.193
SD	.46	.33	.34	.39	Sex	1	.378	2.58	.112
SE	.10	.08	.08	.09	A × S	1	.091	.62	.433
CV	3.11	2.24	2.31	2.68	Error	76	.146		
n	20	20	20	20					
				Length of the mandibular toothrow					
Mean	8.21	8.13	8.13	8.01	Area	1	.181	3.17	.079
SD	.23	.23	.25	.25	Sex	1	.200	3.51	.065
SE	.05	.05	.06	.06	A × S	1	.008	.14	.709
CV	2.80	2.83	3.08	3.12	Error	76	.057		
n	20	20	20	20					
				Length of the coronoid process					
Mean	5.33	5.18	5.25	5.14	Area	1	.072	1.29	.261
SD	.24	.18	.19	.32	Sex	1	.338	6.03	.016
SE	.05	.04	.04	.07	A × S	1	.013	.22	.638
CV	4.50	3.47	3.62	5.23	Error	76	.056		
n	20	20	20	20					

ter, 1976). This frugivore was uncommon in the Caatingas where it was primarily restricted to Caatinga Alta habitats. *S. l. lilium* was also uncommon in both Cerrado and Cerradão habitats of the Chapada do Araripe. Less than 14% of the 22 specimens captured on the Chapada were males; the sex ratio was clearly unequal (Binomial Test, $P < .01$). The small sample from the Caatingas precludes analysis concerning sex ratios. *Vismia* is an important component of this bat's diet on the Chapada do Araripe; no other species of fruit was found in its digestive tract.

An extensive list of authors who have reported morphometric data on *S. lilium* is cited by Swanepoel and Genoways (1979). However, only three authors, Lima (1926), Cunha Vieira (1942), and Taddei (1975*b*), include Brazilian specimens in their work and only Taddei (1975*b*) performs rigorous statistical analyses of individual and secondary sexual variation. He found that *S. lilium* males have larger sample means than females, but that statistically significant variation could not be detected for a suite of 17 external mensural characters. On the other hand, statistically significant secondary sexual variation is apparent for all but two of the 17 cranial characters analyzed, and in all cases, male sample means are larger than female sample means.

The results of a statistical analysis of a sample of *S. lilium* from the Northeast of Brazil yields similar results (see Table 17). Only a single external character (total length) exhibits statistically significant secondary sexual variation and no pattern could be detected when comparing male and female sample means. Males have consistently larger sample means than females for all 16 cranial characters and half of them exhibit statistically significant variation. At least in terms of skull morphology, *S. lilium* is clearly dimorphic with males being larger than females.

Uroderma magnirostrum Davis, 1968

This frugivore is a monotypic species (Jones and Carter, 1976) which was very rare in the Caatingas and on the Chapada do Araripe. The specimens listed by Mares et al. (1981) as *U. bilobatum* from the Northeast of Brazil were in fact *U. magnirostrum*. Other than the original work of Davis (1968), only a few isolated measurements have been reported by Jones et al. (1971) for *U. magnirostrum* from Nicaragua. Selected measurements (after Swanepoel and Genoways, 1979) are reported here for an adult male and female from the Chapada do Araripe and two adult females from the Caatingas (total length: 61, 60, 60, 60; tail length: —, —, —, —; hindfoot length: 11, 11, 10, 11; ear length: 16, 16, 16, 17; greatest length of skull: 23.8, 22.6, 23.0, 23.3; condylobasal length: 22.1, 20.7, 21.2, 21.4; zygomatic breadth: 12.5, 12.4, 12.8, 13.0; postorbital construction: 6.1, 5.9, 5.9, 5.7; breadth of braincase: 9.7, 9.5, 9.4, 9.7; length of the maxillary toothrow: 8.4, 7.8, 8.0, 8.0; and breadth across the

Table 17.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Sturnira lilium *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each external character; the existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050. Due to small sample sizes for the cranial characters, data from both biomes were combined to determine the existence of significant (*P < *.050) secondary sexual variation via a one-way analysis of variance with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Totallength									
Mean	64.33	59.00	60.67	59.95	Area	1	7.629	2.26	.145
SD	1.16	2.00	2.31	1.81	Sex	1	37.795	11.21	.003
SE	.67	1.00	1.33	.42	A × S	1	21.964	6.52	.017
CV	1.80	3.39	3.81	3.02	Error	25	3.371		
n	3	4	3	19					
Hindfoot length									
Mean	12.00	11.50	11.67	11.74	Area	1	.010	.03	.858
SD	0	.58	.58	.56	Sex	1	.191	.65	.428
SE	0	.29	.33	.13	A × S	1	.335	1.14	.296
CV	0	5.04	4.97	4.77	Error	25	.294		
n	3	4	3	19					
Ear length									
Mean	15.67	15.75	16.00	15.79	Area	1	.143	.15	.706
SD	1.16	.50	1.00	1.03	Sex	1	.017	.02	.897
SE	.67	.25	.58	.24	A × S	1	.089	.09	.766
CV	7.40	3.17	6.25	6.52	Error	25	.983		
n	3	4	3	19					
Tragus length									
Mean	6.67	6.75	6.67	6.42	Area	1	.112	.32	.577
SD	.58	.96	.58	.51	Sex	1	.027	.08	.782
SE	.33	.48	.33	.12	A × S	1	.112	.32	.577
CV	8.70	14.22	8.70	7.94	Error	25	.349		
n	3	4	3	19					
Forearm length									
Mean	43.00	42.00	41.33	42.26	Area	1	2.032	1.05	.315
SD	1.73	1.16	1.16	1.41	Sex	1	.005	.000	.960
SE	1.00	.58	.67	.32	A × S	1	3.842	1.99	.171
CV	4.02	2.76	2.81	3.34	Error	25	1.934		
n	3	4	3	19					
Weight									
Mean	22.33	21.00	20.33	20.66	Area	1	5.659	1.25	.274
SD	.29	1.23	1.26	2.42	Sex	1	1.050	.23	.634
SE	.17	.61	.73	.55	A × S	1	2.836	.63	.436
CV	1.30	5.86	6.20	11.71	Error	25	4.514		
n	3	4	3	19					
Length of digit one									
Mean	10.00	10.00	11.00	10.74	Area	1	3.112	4.40	.046
SD	0	1.16	1.00	.81	Sex	1	.071	.10	.753
SE	0	.58	.58	.19	A × S	1	.071	.10	.753
CV	0	11.60	9.09	7.54	Error	25	.707		
n	3	4	3	19					
Length of digit three									
Mean	88.33	86.75	86.33	88.79	Area	1	.002	.00	.987
SD	1.53	2.75	1.53	2.51	Sex	1	.786	.14	.716
SE	.88	1.38	.88	.58	A × S	1	16.834	2.90	.101
CV	1.73	3.17	1.77	2.83	Error	25	5.810		
n	3	4	3	19					

Table 17.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit four									
Mean	65.33	65.25	65.33	66.16	Area	1	.850	.22	.640
SD	1.53	3.10	1.53	1.77	Sex	1	.567	.15	.702
SE	.88	1.55	.88	.41	A × S	1	.850	.22	.640
CV	2.34	4.75	2.34	2.68	Error	25	3.784		
n	3	4	3	19					
Length of digit five									
Mean	61.33	59.75	60.00	61.58	Area	1	.253	.06	.816
SD	1.53	1.26	1.00	2.39	Sex	1	.000	.00	.998
SE	.88	.63	.58	.54	A × S	1	10.317	2.26	.145
CV	2.49	2.11	1.67	3.88	Error	25	4.562		
n	3	4	3	19					
Tibia length									
Mean	16.67	17.75	17.33	17.68	Area	1	.373	.27	.606
SD	3.22	.96	.58	.75	Sex	1	2.122	1.55	.224
SE	1.86	.48	.33	.17	A × S	1	.554	.40	.530
CV	19.32	5.41	3.35	4.24	Error	25	1.368		
n	3	4	3	19					
Noseleaf length									
Mean	5.33	5.50	5.67	5.05	Area	1	.013	.05	.832
SD	.58	.58	.58	.52	Sex	1	.207	.71	.408
SE	.33	.29	.33	.12	A × S	1	.629	2.16	.154
CV	10.88	10.55	10.23	10.30	Error	25	.291		
n	3	4	3	19					
Greatest length of skull									
Mean	22.20	21.43	21.70	21.74	Sex	1	.194	.97	.335
SD	.42	.29	.10	.48	Within	25	.201		
SE	.30	.14	.06	.11					
CV	1.89	1.35	.46	2.21					
n	2	4	3	18					
Condylobasal length									
Mean	20.35	19.63	19.83	19.59	Sex	1	.804	4.86	.037
SD	.35	.46	.15	.42	Within	25	.166		
SE	.25	.23	.09	.10					
CV	1.72	2.34	.76	2.14					
n	2	4	3	18					
Zygomatic breadth									
Mean	13.65	13.38	13.70	13.45	Sex	1	.242	1.93	.177
SD	.64	.22	.30	.38	Within	25	.126		
SE	.45	.11	.17	.09					
CV	4.69	1.64	2.19	2.83					
n	2	4	3	18					
Postorbital constriction									
Mean	6.20	5.93	6.17	5.88	Sex	1	.341	12.41	.002
SD	.14	.26	.12	.16	Within	25	.027		
SE	.10	.13	.07	.04					
CV	2.26	4.38	1.94	2.72					
n	2	4	3	18					
Mastoid breadth									
Mean	12.40	11.90	12.23	11.91	Sex	1	.637	5.88	.023
SD	.57	.29	.35	.33	Within	25	.108		
SE	.40	.15	.20	.08					
CV	4.60	2.44	2.86	2.77					
n	2	4	3	18					

Table 17.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Breadth of braincase					
Mean	10.41	10.00	10.37	10.20	Sex	1	.191	4.11	.053
SD	.14	.14	.40	.19	Within	25	.046		
SE	.10	.07	.23	.05					
CV	1.34	1.40	3.86	1.86					
n	2	4	3	18					
				Rostral breadth					
Mean	7.15	6.75	6.93	6.67	Sex	1	.454	13.60	.001
SD	.07	.17	.25	.18	Within	25	.033		
SE	.05	.09	.15	.04					
CV	.98	2.52	.04	.03					
n	2	4	3	18					
				Height of braincase					
Mean	12.00	11.75	12.40	11.83	Sex	1	.741	11.17	.003
SD	.28	.13	.10	.28	Within	25	.066		
SE	.20	.07	.06	.07					
CV	2.33	1.11	.81	2.37					
n	2	4	3	18					
				Breadth across the upper molars					
Mean	8.35	8.05	8.27	8.10	Sex	1	.178	3.60	.070
SD	.35	.06	.42	.21	Within	25	.050		
SE	.25	.03	.24	.05					
CV	4.19	.75	5.08	2.59					
n	2	4	3	18					
				Breadth across the upper canines					
Mean	6.50	5.95	6.27	5.97	Sex	1	.626	34.01	<.001
SD	0	.10	.15	.14	Within	25	.018		
SE	0	.05	.09	.03					
CV	0	1.68	2.39	2.35					
n	2	4	3	18					
				Length of the maxillary toothrow					
Mean	6.90	6.53	6.57	6.59	Sex	1	.061	1.32	.261
SD	.14	.17	.12	.23	Within	25	.043		
SE	.10	.09	.07	.05					
CV	2.03	2.60	1.83	3.49					
n	2	4	3	18					
				Length of the upper molariform toothrow					
Mean	5.35	5.15	5.27	5.07	Sex	1	.186	6.40	.018
SD	.07	.19	.15	.18	Within	25	.029		
SE	.05	.10	.09	.04					
CV	1.31	3.69	2.85	3.55					
n	2	4	3	18					
				Width of the widest molar					
Mean	1.80	1.70	1.83	1.81	Sex	1	.003	.38	.543
SD	0	.08	.06	.10	Within	25	.009		
SE	0	.04	.03	.02					
CV	0	4.71	3.28	5.52					
n	2	4	3	18					
				Greatest length of the mandible					
Mean	14.55	14.00	14.40	14.30	Sex	1	.188	1.03	.320
SD	.35	.41	.10	.46	Within	25	.182		
SE	.25	.20	.06	.10					
CV	2.40	2.93	.69	3.22					
n	2	4	3	18					

Table 17.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of the mandibular toothrow					
Mean	7.90	7.35	7.53	7.35	Sex	1	.444	9.88	.004
SD	.28	.17	.06	.22	Within	25			
SE	.20	.09	.03	.05					
CV	3.54	2.31	.80	2.99					
n	2	4	3	18					
				Length of the coronoid process					
Mean	5.60	5.35	5.53	5.42	Sex	1	.093	2.44	.131
SD	0	.13	.25	.21	Within	25	.038		
SE	0	.07	.15	.05					
CV	0	2.43	4.52	3.87					
n	2	4	3	18					

upper molars: 9.1, 9.2, 9.5, 9.3). These measurements do not differ from the data reported by Swanepoel and Genoways (1979) for *U. magnirostrum.*

Vampyrops lineatus (E. Geoffroy, 1810)

This frugivore was very abundant and ubiquitous in both Caatingas and Cerrado habitats. *Vismia* was a very important component in its diet on the Chapada do Araripe. In the Caatingas, 39% of the 217 captured adult specimens were males; 17% of the 229 captured adult specimens from the Cerrado were males. Both populations exhibited unequal sex ratios (Binomial Test, $P < .01$). Observations at a number of roosting sites in the Caatingas suggested that males often maintain small harems of 7 to 15 females. Single harems occupied each roosting site and individuals within the harem maintained body contact throughout the day. Daily netting records further suggested the existence of male foraging groups. Roosting sites that exclusively contained males were never discovered, perhaps these bachelor males roosted individually and foraged only as a group.

Little has been published on intraspecific variation in *V. lineatus* (Swanepoel and Genoways, 1979) and, although frequently considered a monotypic species (see Koopman, 1979, for an alternate view), some confusion exists concerning its systematic relationship with *V. recifinus.* Lima (1926), Cunha Vieira (1942), and Sanborn (1955) reported some cranial measurements on extremely small samples of *V. lineatus* from Brazil, but no quantitative systematic comparisons were attempted. Taddei (1979) found statistically significant secondary sexual variation in only two of 18 cranial measurements (palate width and basal length) and in five of 18 external characters (forearm, metacarpal of digit III, first phalanx of digit III, third phalanx of digit III and the metaearpal of digit IV) for specimens from northwestern São Paulo, Brazil.

I was able to detect significant secondary sexual variation in nine of 14 external characters but was unable to detect differences in any of the analyzed cranial characters; statistically significant differences between Caatingas and Cerrado biomes exist in four cranial and four external characters (Table 18).

Artibeus concolor Peters, 1865

This frugivore is a monotypic species which was apparently absent from the Caatingas and rare on the Chapada do Araripe. Little has been reported on the morphometric characteristics of *A. concolor* (see Swanepoel and Genoways, 1979) and Cabrera (1917) is the only author who has included a specimen of likely Brazilian origin in his work.

Although samples of *A. concolor* from the Chapada do Araripe are small, they are of sufficient size to allow a statistical analysis of individual and secondary sexual variation in this species (Table 19). There is a clear trend in both external and cranial characters for females to have larger sample means than males; statistically significant secondary sexual variation is exhibited by five external and three cranial characters. In all cases of statistical significance, the female mean value is larger than the male mean value which also suggests sex-related size dimorphism in the population.

Artibeus jamaicensis Leach, 1821

Infraspecific variation in this frugivore is poorly understood for Central and South American populations (see Koopman, 1978, for a discussion of

Table 18.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Vampyrops lineatus *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model 1) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	64.40	67.85	63.55	66.70	Area	1	20.000	2.63	.109
SD	2.98	2.60	2.78	2.66	Sex	1	217.800	28.61	<.001
SE	.67	.58	.62	.59	A × S	1	.450	.06	.809
CV	4.63	3.83	4.37	3.99	Error	76	7.612		
n	20	20	20	20					
Hindfoot length									
Mean	11.20	11.60	11.55	11.90	Area	1	2.113	7.06	.010
SD	.62	.60	.51	.45	Sex	1	2.813	9.40	.003
SE	.14	.13	.11	.10	A × S	1	.013	.04	.839
CV	5.54	5.17	4.42	3.87	Error	76	.299		
n	20	20	20	20					
Ear length									
Mean	18.05	18.15	17.80	18.15	Area	1	.313	.45	.506
SD	1.05	.67	.89	.67	Sex	1	1.013	1.45	.233
SE	.24	.15	.20	.15	A × S	1	.313	.45	.506
CV	5.82	3.69	5.00	3.69	Error	76	.701		
n	20	20	20	20					
Tragus length									
Mean	7.15	7.35	7.30	7.10	Area	1	.050	.11	.736
SD	.75	.59	.57	.72	Sex	1	.000	.00	1.000
SE	.17	.13	.13	.16	A × S	1	.800	1.84	.179
CV	10.49	8.03	7.81	10.14	Error	76	.436		
n	20	20	20	20					
Forearm length									
Mean	47.20	47.45	46.00	47.20	Area	1	10.513	4.09	.047
SD	1.94	2.04	1.12	1.06	Sex	1	10.513	4.09	.047
SE	.43	.46	.25	.24	A × S	1	4.513	1.76	.189
CV	4.11	4.30	2.43	2.25	Error	76	2.570		
n	20	20	20	20					
Weight									
Mean	23.93	26.44	23.10	26.48	Area	1	3.121	.46	.501
SD	1.32	3.73	1.78	2.90	Sex	1	173.461	25.45	<.001
SE	.30	.84	.40	.65	A × S	1	3.698	.54	.464
CV	5.52	14.11	7.71	10.95	Error	76	6.815		
n	20	20	20	20					
Length of digit one									
Mean	10.65	10.95	10.60	11.10	Area	1	.050	.09	.759
SD	.75	.76	.75	.64	Sex	1	3.200	6.06	.016
SE	.17	.17	.17	.14	A × S	1	.200	.38	.540
CV	7.04	6.94	7.08	5.77	Error	76	.528		
n	20	20	20	20					
Length of digit three									
Mean	96.80	97.10	94.00	97.35	Area	1	32.513	3.37	.070
SD	3.49	3.70	2.64	2.41	Sex	1	66.613	6.90	.010
SE	.78	.83	.59	.54	A × S	1	46.513	4.82	.031
CV	3.61	3.81	2.81	2.48	Error	76	9.652		
n	20	20	20	20					

Table 18.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of digit four					
Mean	70.95	71.90	69.35	71.05	Area	1	30.013	6.48	.013
SD	2.04	2.55	2.03	1.93	Sex	1	35.113	7.58	.007
SE	.46	.57	.46	.43	A × S	1	2.813	.61	.438
CV	2.88	3.55	2.93	2.72	Error	76	4.635		
n	20	20	20	20					
				Length of digit five					
Mean	65.75	67.25	64.35	66.10	Area	1	32.513	7.10	.009
SD	1.94	2.86	1.90	1.65	Sex	1	52.813	11.54	.001
SE	.44	.64	.43	.37	A × S	1	.313	.07	.795
CV	2.95	4.25	2.95	2.50	Error	76	4.577		
n	20	20	20	20					
				Tibia length					
Mean	18.00	18.35	17.95	18.50	Area	1	.050	.09	.766
SD	.46	.88	.76	.83	Sex	1	4.050	7.24	.009
SE	.10	.20	.17	.19	A × S	1	.200	.36	.552
CV	2.56	4.80	4.23	4.49	Error	76	.559		
n	20	20	20	20					
				Calcar length					
Mean	4.75	4.30	4.25	4.30	Area	1	1.250	3.41	.069
SD	.85	.57	.44	.47	Sex	1	.800	2.18	.144
SE	.19	.13	.10	.10	A × S	1	1.250	3.41	.069
CV	17.89	13.26	10.35	10.93	Error	76	.367		
n	20	20	20	20					
				Noseleaf length					
Mean	6.95	7.00	6.85	7.25	Area	1	.113	.18	.672
SD	.76	.86	.88	.64	Sex	1	1.013	1.63	.206
SE	.17	.19	.20	.14	A × S	1	.613	.99	.324
CV	10.94	12.29	12.85	8.83	Error	76	.623		
n	20	20	20	20					
				Greatest length of skull					
Mean	24.32	24.40	24.38	24.41	Area	1	.018	.09	.762
SD	.46	.37	.56	.35	Sex	1	.061	.31	.579
SE	.10	.08	.13	.08	A × S	1	.013	.06	.801
CV	1.89	1.52	2.30	1.43	Error	76	.195		
n	20	20	20	20					
				Condylobasal length					
Mean	21.90	22.00	21.83	21.89	Area	1	.181	.78	.379
SD	.44	.46	.61	.38	Sex	1	.128	.56	.459
SE	.10	.10	.14	.09	A × S	1	.005	.02	.889
CV	2.01	2.09	2.79	1.74	Error	76	.231		
n	20	20	20	20					
				Zygomatic breadth					
Mean	14.32	14.37	14.25	14.17	Area	1	.365	2.61	.111
SD	.34	.40	.37	.39	Sex	1	.005	.03	.858
SE	.08	.09	.08	.09	A × S	1	.098	.70	.405
CV	2.37	2.78	2.60	2.75	Error	76	.140		
n	20	20	20	20					
				Postorbital constriction					
Mean	6.26	6.29	6.23	6.22	Area	1	.045	1.07	.304
SD	.19	.20	.18	.25	Sex	1	.001	.03	.871
SE	.04	.04	.04	.06	A × S	1	.010	.24	.626
CV	3.04	3.18	2.89	4.02	Error	76	.042		
n	20	20	20	20					

Table 18.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Mastoid breadth									
Mean	12.12	12.22	12.21	12.16	Area	1	.005	.05	.822
SD	.26	.31	.24	.32	Sex	1	.013	.14	.707
SE	.06	.07	.07	.07	A × S	1	.113	1.28	.262
CV	2.15	2.54	1.97	2.63	Error	76	.088		
n	20	20	20	20					
Breadth of braincase									
Mean	10.51	10.56	10.56	10.58	Area	1	.021	.37	.544
SD	.29	.26	.23	.16	Sex	1	.021	.37	.544
SE	.06	.06	.05	.04	A × S	1	.003	.06	.815
CV	2.76	2.46	2.18	1.51	Error	76	.057		
n	20	20	20	20					
Rostral breadth									
Mean	7.46	7.42	7.03	6.86	Area	1	4.950	57.83	<.001
SD	.26	.31	.36	.21	Sex	1	.210	2.45	.121
SE	.06	.07	.08	.05	A × S	1	.078	.91	.342
CV	3.49	4.18	5.12	3.06	Error	76	.086		
n	20	20	20	20					
Height of braincase									
Mean	12.48	12.42	12.44	12.36	Area	1	.045	.63	.429
SD	.23	.31	.29	.24	Sex	1	.105	1.48	.228
SE	.05	.07	.07	.05	A ×S	1	.001	.02	.900
CV	1.84	2.50	2.33	1.94	Error	76	.071		
n	20	20	20	20					
Breadth across the upper molars									
Mean	10.19	10.40	10.17	10.13	Area	1	.406	5.92	.017
SD	.23	.31	.25	.25	Sex	1	.153	2.23	.139
SE	.05	.07	.06	.06	A × S	1	.325	4.74	.033
CV	2.26	2.98	2.46	2.47	Error	76	.069		
n	20	20	20	20					
Breadth across the upper canines									
Mean	6.05	6.15	6.09	6.02	Area	1	.045	1.08	.302
SD	.22	.23	.15	.21	Sex	1	.006	.15	.703
SE	.05	.05	.03	.05	A × S	1	.153	3.67	.059
CV	3.64	3.74	2.46	3.49	Error	76	.042		
n	20	20	20	20					
Length of the maxillary toothrow									
Mean	8.59	8.75	8.76	8.62	Area	1	.010	.11	.738
SD	.33	.32	.28	.27	Sex	1	.001	.01	.911
SE	.07	.07	.06	.06	A × S	1	.435	4.83	.031
CV	3.84	3.66	3.20	3.13	Error	76	.090		
n	20	20	20	20					
Length of the upper molariform toothrow									
Mean	7.09	7.16	7.05	7.98	Area	1	.231	3.95	.050
SD	.26	.28	.21	.20	Sex	1	.000	.00	.963
SE	.06	.06	.05	.05	A × S	1	.105	1.80	.184
CV	3.67	3.91	2.98	2.51	Error	76	.059		
n	20	20	20	20					
Width of the widest molar									
Mean	2.51	2.53	2.42	2.45	Area	1	.145	8.03	.006
SD	.11	.13	.14	.16	Sex	1	.018	1.00	.320
SE	.02	.03	.03	.04	A × S	1	.001	.03	.868
CV	4.38	5.14	5.79	6.53	Error	76	.018		
n	20	20	20	20					

Table 18.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Greatest length of the mandible				
Mean	16.62	16.74	16.49	16.49	Area	1	.722	4.73	.033
SD	.48	.28	.45	.32	Sex	1	.072	.47	.494
SE	.11	.06	.10	.07	A × S	1	.085	.55	.459
CV	2.89	1.67	2.73	1.94	Error	76	.153		
n	20	20	20	20					
					Length of the mandibular toothrow				
Mean	9.53	9.60	9.54	9.46	Area	1	.098	1.25	.267
SD	.26	.33	.25	.26	Sex	1	.001	.01	.937
SE	.06	.08	.06	.06	A × S	1	.113	1.44	.235
CV	2.73	3.44	2.62	2.75	Error	76	.078		
n	20	20	20	20					
					Length of the coronoid process				
Mean	5.69	5.87	5.76	5.74	Area	1	.018	.28	.595
SD	.25	.25	.29	.21	Sex	1	.128	2.03	.159
SE	.06	.06	.07	.05	A × S	1	.181	2.86	.095
CV	4.39	4.26	5.03	3.66	Error	76	.063		
n	20	20	20	20					

Table 19.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Artibeus concolor *males and females from the Cerrado biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Total length				
Mean			58.33	61.50	Sex	1	30.083	7.02	.024
SD			2.07	2.07	Within	10	4.283		
SE			.84	.85					
CV			3.55	3.37					
n			6	6					
					Hindfoot length				
Mean			10.33	10.33	Sex	1	.000	.000	1.000
SD			.52	.52	Within	10	.267		
SE			.21	.21					
CV			5.03	5.03					
n			6	6					
					Ear length				
Mean			17.00	17.00	Sex	1	.000	.000	1.000
SD			.63	.63	Within	10	.400		
SE			.26	.26					
CV			3.71	3.71					
n			6	6					
					Tragus length				
Mean			6.50	7.50	Sex	1	3.000	6.00	.034
SD			.84	.55	Within	10	.500		
SE			.34	.22					
CV			12.92	7.33					
n			6	6					

Table 19.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Forearm length									
Mean			47.00	47.33	Sex	1	.333	.09	.771
SD			2.19	1.63	Within	10	3.733		
SE			.89	.67					
CV			4.66	3.44					
n			6	6					
Weight									
Mean			18.42	21.42	Sex	1	27.000	16.45	.002
SD			.86	1.59	Within	10	1.642		
SE			.35	.65					
CV			4.67	7.42					
n			6	6					
Length of digit one									
Mean			10.67	10.17	Sex	1	.750	1.22	.296
SD			.52	.98	Within	10	.617		
SE			.21	.41					
CV			4.87	9.64					
n			6	6					
Length of digit three									
Mean			96.33	99.50	Sex	1	30.083	2.02	.186
SD			4.68	2.81	Within	10	14.883		
SE			1.91	1.15					
CV			4.86	2.82					
n			6	6					
Length of digit four									
Mean			73.17	73.50	Sex	1	.333	.04	.850
SD			3.49	2.35	Within	10	8.833		
SE			1.42	.96					
CV			4.77	3.20					
n			6	6					
Length of digit five									
Mean			69.17	68.67	Sex	1	.750	.07	.794
SD			4.12	1.97	Within	10	10.417		
SE			1.68	.80					
CV			5.96	2.87					
n			6	6					
Tibia length									
Mean			18.50	18.33	Sex	1	.083	.08	.787
SD			1.05	1.03	Within	10	1.083		
SE			.43	.42					
CV			5.68	5.62					
n			6	6					
Calcar length									
Mean			5.67	6.67	Sex	1	3.000	6.43	.030
SD			.82	.52	Within	10	.467		
SE			.33	.21					
CV			14.46	7.80					
n			6	6					
Noseleaf length									
Mean			6.67	7.33	Sex	1	1.333	5.00	.049
SD			.52	.52	Within	10	.267		
SE			.21	.21					
CV			7.80	7.09					
n			6	6					

Table 19.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Greatest length of skull					
Mean			21.22	21.23	Sex	1	.001	.00	.957
SD			.40	.40	Within	9	.160		
SE			.18	.17					
CV			1.89	1.88					
n			5	6					
				Condylobasal length					
Mean			18.84	19.18	Sex	1	.322	3.21	.107
SD			.35	.29	Within	9	.100		
SE			.16	.12					
CV			1.86	1.51					
n			5	6					
				Zygomatic breadth					
Mean			13.00	13.17	Sex	1	.076	1.19	.304
SD			.19	.29	Within	9	.064		
SE			.08	.12					
CV			1.46	2.20					
n			5	6					
				Postorbital constriction					
Mean			5.44	5.47	Sex	1	.002	.20	.662
SD			.09	.10	Within	9	.010		
SE			.04	.04					
CV			1.65	1.83					
n			5	6					
				Mastoid breadth					
Mean			11.12	11.53	Sex	1	.466	11.00	.009
SD			.13	.25	Within	9	.042		
SE			.06	.10					
CV			1.17	2.17					
n			5	6					
				Breadth of braincase					
Mean			9.90	9.80	Sex	1	.027	.35	.568
SD			.31	.25	Within	9	.078		
SE			.14	.10					
CV			3.13	2.55					
n			5	6					
				Rostral breadth					
Mean			6.96	7.43	Sex	1	.611	14.27	.004
SD			.20	.22	Within	9	.043		
SE			.09	.09					
CV			2.87	2.96					
n			5	6					
				Height of braincase					
Mean			11.60	11.42	Sex	1	.092	1.02	.339
SD			.27	.32	Within	9	.090		
SE			.12	.13					
CV			2.33	2.80					
n			5	6					
				Breadth across the upper molars					
Mean			9.14	9.48	Sex	1	.322	6.29	.034
SD			.20	.25	Within	9	.051		
SE			.09	.10					
CV			2.19	2.64					
n			5	6					

Table 19.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
			Breadth across the upper canines						
Mean			5.78	5.87	Sex	1	.021	.24	.639
SD			.21	.35	Within	9	.087		
SE			.09	.14					
CV			3.63	5.96					
n			5	6					
			Length of the maxillary toothrow						
Mean			6.82	7.02	Sex	1	.106	2.28	.165
SD			.26	.17	Within	9	.046		
SE			.12	.07					
CV			3.81	2.42					
n			5	6					
			Length of the upper molariform toothrow						
Mean			5.68	6.02	Sex	1	.309	5.00	.052
SD			.18	.29	Within	9	.062		
SE			.08	.12					
CV			3.17	4.82					
n			5	6					
			Width of the widest molar						
Mean			2.38	2.45	Sex	1	.013	1.91	.200
SD			.08	.08	Within	9	.007		
SE			.04	.03					
CV			3.36	3.26					
n			5	6					
			Greatest length of the mandible						
Mean			13.84	13.98	Sex	1	.056	.55	.478
SD			.37	.27	Within	9	.102		
SE			.16	.11					
CV			2.67	1.93					
n			5	6					
			Length of the mandibular toothrow						
Mean			7.52	7.63	Sex	1	.035	.45	.519
SD			.37	.18	Within	9	.078		
SE			.17	.07					
CV			4.92	2.36					
n			5	6					
			Length of the coronoid process						
Mean			5.56	5.65	Sex	1	.022	.57	.468
SD			.11	.24	Within	9	.039		
SE			.05	.10					
CV			1.98	4.25					
n			5	6					

probable systematic relations), hence it seems premature to assign a subspecific designation to Northeast Brazilian populations. This species was abundant and ubiquitous in both Cerrado and Cerradão habitats on the Chapada do Araripe; *Vismia* was the predominant fruit in its diet there. It was present in the Caatingas and reached its highest density on or near serrotes. The proportion of males was not equal to the proportion of females within either Caatingas or Cerrado biomes (Binomial Tests, $P < .01$). Twenty-eight percent of the 204 captured adult specimens from the Caatingas were males, whereas 40% of the 270 captured adult specimens from the Cerrado were males.

A plethora of references including morphometric data on *A. jamaicensis* are cited by Swanepoel and Genoways (1979), but only Rehn (1900, 1902), G. M. Allen (1908), Andersen (1908), and Cunha Vieira (1942) report measurements from Brazilian specimens. Davis (1970) examined individual, secondary sexual, and geographic variation in specimens of *A. jamaicensis* from Middle America, but no one has examined variation in a statistically rigorous manner for South American specimens.

Table 20 details the results of statistical analyses of individual, secondary sexual and geographic variation in Brazilian specimens of *A. jamaicensis* from Caatingas and Cerrado biomes. Statistically significant geographic variation was detected for seven external and ten cranial characters; in all of these cases, the sample means for Caatingas specimens are larger than the sample means for Cerrado specimens. These two distinct yet geographically proximate populations are clearly dimorphic. Secondary sexual variation is not apparent for *A. jamaicensis* when considering external morphometric variables (only weight is statistically significant); however, males have larger sample means than females for eleven cranial characters and the variation is statistically significant for five of them. Females, on the other hand, were never larger than males when considering sample means for cranial characters. There is then, appreciable secondary sexual variation exhibited by cranial characters and strong evidence for sexual dimorphism for size with males being larger than females. This is unlike the results obtained by Davis (1970) who found no significant secondary sexual variation in samples from numerous localities in Central America. This failure to detect significant variation was most likely caused by the large quantity of variation attributable to geographic heterogeneity in Davis' samples which was not statistically removed from his analysis of secondary sexual variation.

Artibeus lituratus (Olfers, 1818)

Infraspecific relationships for this species are poorly understood at the present (see for example Koopman, 1976); as such, it is best to avoid using a provisional subspecific appellation for populations from the Brazilian Northeast. This frugivore was widespread and abundant in both Cerrado and Cerradão habitats; *Vismia* was the predominant fruit in its diet on the Chapada do Araripe. It was widespread but uncommon in the Caatingas. Within both Caatingas and Cerrado biomes, the sexes occurred in equal frequency (Binomial Test, $P > .05$). Of the 44 captured adult specimens from the Caatingas, 45% were males. Similarly, 58% of the 366 captured adults from the Cerrado were males.

Morphometric data on *A. lituratus* appears in the literature many times (see Swanepoel and Genoways, 1979), but only G. M. Allen (1908), Andersen (1908), Cunha Vieira (1942), and Pirlot (1972) consider Brazilian specimens. Secondary sexual variation in *A. lituratus* was examined by Anderson (1960) and Tamsitt and Valdivieso (1963), but only the former performed statistical analyses, and there was no significant secondary sexual variation detected in that study. Geographic variation in mensural characters for *A. lituratus* was examined by Dalquest (1950) and Tamsitt and Valdivieso (1963) but no statistical results are reported. Further, individual variation in morphometric characters has not been investigated in this species.

The results of a statistical analysis of individual, secondary sexual, and geographic variation for populations of *A. lituratus* from Cerrado and Caatingas biomes are summarized in Table 21. Four external characters exhibit statistically significant secondary sexual variation, whereas none of the cranial characters exhibit statistical differences between males and females. Obvious trends in mean values for males and females are not observed; trends in mean values for Caatingas and Cerrado populations are also not evident. However, a group of five cranial characters exhibits statistically significant secondary sexual variation in which four male mean values are larger than the comparable female mean values. Only a single external character shows statistically significant sexual variation. Secondary sexual variation occurs in populations of *A. lituratus* but is not extensive.

Subfamily Desmodontinae

Desmodus rotundus (E. Geoffroy, 1810)

Of the two extant subspecies, *D. r. rotundus* is the designation properly applied to Northeast Brazilian populations of this sanguinivore (Jones and Carter, 1976). It was common in the Caatingas where it was locally abundant on serrotes. Of the 365 captured adult specimens from the Caatingas, 45% were males; as such the sexes occurred in statistically indistinguishable proportions (Binomial Test, $P > .05$). It was rare in Cerrado and Cerradão habitats of the Chapada do Araripe, perhaps due to the paucity of livestock and other large wild mammals.

Table 20.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Artibeus jamaicensis *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Total length				
Mean	74.85	75.85	73.20	73.75	Area	1	70.313	7.36	.008
SD	2.98	3.08	3.12	3.18	Sex	1	12.013	1.26	.266
SE	.67	.69	.70	.71	A × S	1	1.013	.11	.746
CV	3.98	4.06	4.26	4.31	Error	76	9.553		
n	20	20	20	20					
					Hindfoot length				
Mean	13.25	13.65	13.30	13.35	Area	1	.313	.43	.513
SD	.79	1.09	.66	.81	Sex	1	1.013	1.40	.241
SE	.18	.24	.15	.18	A × S	1	.613	.85	.361
CV	5.96	7.99	4.96	6.07	Error	76	.724		
n	20	20	20	20					
					Ear length				
Mean	20.55	20.55	20.40	20.35	Area	1	.613	.65	.421
SD	.95	.95	.88	1.09	Sex	1	.013	.01	.908
SE	.21	.21	.20	.24	A × S	1	.013	.01	.908
CV	4.62	4.62	4.31	5.36	Error	76	.938		
n	20	20	20	20					
					Tragus length				
Mean	8.15	8.20	8.10	8.10	Area	1	.113	.34	.563
SD	.59	.62	.55	.55	Sex	1	.013	.04	.847
SE	.13	.14	.12	.12	A × S	1	.013	.04	.847
CV	7.24	7.56	6.70	6.79	Error	76	.334		
n	20	20	20	20					
					Forearm length				
Mean	58.95	59.45	57.40	57.20	Area	1	72.200	16.43	<.001
SD	2.16	1.47	2.14	2.48	Sex	1	.450	.10	.750
SE	.48	.33	.48	.56	A × S	1	2.450	.56	.458
CV	3.66	2.47	3.73	4.34	Error	76	4.393		
n	20	20	20	20					
					Weight				
Mean	40.98	46.38	39.40	41.03	Area	1	239.778	14.13	<.001
SD	3.48	5.84	2.08	4.17	Sex	1	246.753	14.54	<.001
SE	.78	1.31	.46	.93	A × S	1	71.253	4.20	.044
CV	8.49	12.59	5.28	10.16	Error	76	16.970		
n	20	20	20	20					
					Length of digit one				
Mean	11.65	11.70	11.75	11.45	Area	1	.113	.19	.666
SD	.75	.87	.72	.76	Sex	1	.313	.52	.472
SE	.17	.19	.16	.17	A × S	1	.613	1.02	.315
CV	6.44	7.44	6.13	6.64	Error	76	.598		
n	20	20	20	20					
					Length of digit three				
Mean	113.30	114.45	111.65	111.30	Area	1	115.200	5.89	.018
SD	4.23	4.81	3.58	4.94	Sex	1	3.200	.16	.687
SE	.95	1.08	.80	1.11	A × S	1	11.250	.58	.451
CV	3.73	4.20	3.21	4.44	Error	76	19.551		
n	20	20	20	20					

Table 20.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of digit four					
Mean	86.45	87.85	84.95	85.25	Area	1	18.050	7.81	.007
SD	2.74	3.27	2.52	4.30	Sex	1	14.450	1.34	.250
SE	.61	.73	.56	.96	A × S	1	6.050	.56	.456
CV	3.17	3.72	2.97	5.04	Error	76	10.766		
n	20	20	20	20					
				Length of digit five					
Mean	79.80	81.45	77.70	77.65	Area	1	174.050	22.77	<.001
SD	2.44	1.64	2.03	4.22	Sex	1	12.800	1.67	.200
SE	.55	.37	.45	.94	A × S	1	14.450	1.89	.173
CV	3.06	2.01	2.61	5.43	Error	76	7.643		
n	20	20	20	20					
				Tibia length					
Mean	23.60	23.40	23.05	22.80	Area	1	6.613	3.93	.051
SD	1.50	.60	1.23	1.61	Sex	1	1.013	.60	.440
SE	.34	.13	.28	.36	A × S	1	.013	.01	.932
CV	6.36	2.56	5.34	7.06	Error	76	1.681		
n	20	20	20	20					
				Calcar length					
Mean	6.45	6.50	6.00	6.25	Area	1	2.450	2.92	.091
SD	.83	1.05	.92	.85	Sex	1	.450	.54	.466
SE	.19	.24	.21	.19	A × S	1	.200	.24	.627
CV	12.87	16.15	15.33	13.60	Error	76	.838		
n	20	20	20	20					
				Noseleaf length					
Mean	6.80	6.45	6.50	6.45	Area	1	.450	1.22	.273
SD	.62	.51	.51	.76	Sex	1	.800	2.16	.145
SE	.14	.11	.12	.17	A × S	1	.450	1.22	.273
CV	9.12	7.91	7.85	11.78	Error	76	.370		
n	20	20	20	20					
				Greatest length of skull					
Mean	27.68	27.61	27.30	26.96	Area	1	5.305	17.47	.001
SD	.53	.43	.51	.70	Sex	1	.841	2.77	.100
SE	.12	.10	.11	.16	A × S	1	.338	1.11	.295
CV	1.91	1.56	1.87	2.60	Error	76	.304		
n	20	20	20	20					
				Condylobasal length					
Mean	24.41	24.37	24.17	23.91	Area	1	2.485	9.49	.003
SD	.59	.38	.41	.62	Sex	1	.465	1.78	.187
SE	.13	.08	.09	.14	A × S	1	.253	.97	.329
CV	2.42	1.56	1.70	2.59	Error	76	.262		
n	20	20	20	20					
				Zygomatic breadth					
Mean	17.20	17.07	16.87	16.62	Area	1	3.121	17.05	<.001
SD	.38	.30	.42	.58	Sex	1	.761	4.16	.045
SE	.08	.07	.09	.13	A × S	1	.061	.33	.567
CV	2.21	1.76	2.49	3.49	Error	76	.183		
n	20	20	20	20					
				Postorbital constriction					
Mean	6.99	6.92	6.99	6.82	Area	1	.050	1.03	.312
SD	.24	.15	.28	.20	Sex	1	.265	5.47	.022
SE	.05	.03	.06	.04	A × S	1	.050	1.03	.312
CV	2.43	2.17	4.01	2.93	Error	76	.048		
n	20	20	20	20					

Table 20.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Mastoid breadth					
Mean	15.08	14.90	14.95	14.60	Area	1	.925	7.15	.009
SD	.31	.34	.40	.38	Sex	1	1.458	11.28	.001
SE	.07	.08	.09	.09	A × S	1	.144	1.12	.294
CV	2.06	2.28	2.68	2.60	Error	76	.129		
n	20	20	20	20					
				Breadth of braincase					
Mean	12.28	12.27	12.26	12.07	Area	1	.253	4.38	.040
SD	.19	.28	.22	.26	Sex	1	.190	3.29	.074
SE	.04	.06	.05	.06	A × S	1	.171	2.96	.089
CV	1.55	2.28	1.79	2.15	Error	76	.058		
n	20	20	20	20					
				Rostral breadth					
Mean	8.88	9.02	8.98	8.76	Area	1	.128	1.54	.218
SD	.35	.18	.25	.34	Sex	1	.032	.39	.537
SE	.08	.04	.06	.08	A × S	1	.648	7.80	.007
CV	3.94	2.00	2.78	3.88	Error	76	.083		
n	20	20	20	20					
				Height of braincase					
Mean	14.21	14.06	13.99	13.86	Area	1	.882	7.04	.010
SD	.29	.22	.37	.49	Sex	1	.392	3.13	.081
SE	.06	.05	.08	.11	A × S	1	.005	.04	.850
CV	2.04	1.56	2.64	3.54	Error	76	.125		
n	20	20	20	20					
				Breadth across the upper molars					
Mean	12.44	12.34	12.38	11.99	Area	1	.841	6.82	.011
SD	.34	.22	.34	.46	Sex	1	1.201	9.74	.003
SE	.08	.05	.08	.10	A × S	1	.421	3.41	.069
CV	2.73	1.78	2.75	3.84	Error	76	.123		
n	20	20	20	20					
				Breadth across the upper canines					
Mean	7.95	7.98	7.94	7.53	Area	1	1.035	14.22	<.001
SD	.28	.22	.28	.30	Sex	1	.741	10.18	.002
SE	.06	.05	.06	.07	A × S	1	.990	13.60	<.001
CV	3.52	2.76	3.53	3.98	Error	76	.073		
n	20	20	20	20					
				Length of the maxillary toothrow					
Mean	9.83	9.78	9.91	9.60	Area	1	.055	.68	.411
SD	.26	.30	.29	.29	Sex	1	.630	7.82	.007
SE	.06	.07	.06	.06	A × S	1	.325	4.04	.408
CV	2.65	3.07	2.93	3.02	Error	76	.081		
n	20	20	20	20					
				Length of the upper molariform toothrow					
Mean	8.09	8.20	8.10	7.83	Area	1	.648	10.12	.002
SD	.22	.25	.30	.24	Sex	1	.145	2.26	.137
SE	.05	.06	.07	.05	A × S	1	.722	11.28	.001
CV	2.72	3.05	3.70	3.07	Error	76	.064		
n	20	20	20	20					
				Width of the widest molar					
Mean	3.64	3.62	3.76	3.60	Area	1	.050	2.06	.156
SD	.11	.16	.18	.17	Sex	1	.145	5.95	.017
SE	.03	.04	.04	.04	A × S	1	.098	4.03	.048
CV	3.02	4.42	4.79	4.72	Error	76	.024		
n	20	20	20	20					

Table 20.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Greatest length of the mandible									
Mean	18.92	18.81	18.75	18.63	Area	1	.595	4.34	.041
SD	.44	.32	.28	.42	Sex	1	.253	1.85	.178
SE	.10	.07	.06	.09	A × S	1	.001	.01	.928
CV	2.33	1.70	1.49	2.25	Error	76	.137		
n	20	20	20	20					
Length of the mandibular toothrow									
Mean	10.70	10.73	10.60	10.38	Area	1	1.035	13.07	.001
SD	.20	.20	.37	.32	Sex	1	.171	2.16	.146
SE	.05	.04	.08	.07	A × S	1	.325	4.11	.046
CV	1.87	1.86	3.49	3.08	Error	76	.079		
n	20	20	20	20					
Length of the coronoid process									
Mean	8.14	8.11	8.07	8.09	Area	1	.045	.55	.460
SD	.29	.28	.32	.25	Sex	1	.001	.01	.907
SE	.07	.06	.07	.06	A × S	1	.015	.18	.669
CV	3.56	3.45	3.97	3.09	Error	76	.082		
n	20	20	20	20					

Table 21.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Artibeus lituratus *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	88.55	90.40	86.65	91.20	Area	1	6.05	.41	.524
SD	3.52	4.33	3.30	4.11	Sex	1	204.80	13.90	<.001
SE	.79	.97	.74	.92	A × S	1	36.45	2.47	.120
CV	3.98	4.79	3.81	4.51	Error	76	14.73		
n	20	20	20	20					
Hindfoot length									
Mean	16.65	16.25	16.50	16.30	Area	1	.050	.05	.828
SD	1.09	1.02	.95	1.03	Sex	1	1.800	1.72	.194
SE	.24	.23	.21	.23	A × S	1	.200	.19	.663
CV	6.55	6.28	5.76	6.32	Error	76	1.046		
n	20	20	20	20					
Ear length									
Mean	22.65	22.30	22.10	22.70	Area	1	.113	.06	.800
SD	1.09	1.84	.64	1.42	Sex	1	.313	.18	.674
SE	.24	.41	.14	.32	A × S	1	4.513	2.58	.112
CV	4.81	8.25	2.90	6.26	Error	76	1.748		
n	20	20	20	20					
Tragus length									
Mean	8.50	8.50	8.55	8.75	Area	1	.450	.93	.337
SD	.61	.61	.89	.64	Sex	1	.200	.41	.522
SE	.14	.14	.20	.14	A × S	1	.200	.41	.522
CV	7.18	7.18	10.41	7.31	Error	76	.483		
n	20	20	20	20					

Table 21.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Forearm length									
Mean	70.60	71.90	69.75	70.95	Area	1	16.200	1.82	.182
SD	2.56	3.87	2.63	2.69	Sex	1	31.250	3.51	.065
SE	.57	.86	.59	.60	A × S	1	.050	.01	.941
CV	3.63	5.38	3.77	3.79	Error	76	8.912		
n	20	20	20	20					
Weight									
Mean	69.35	76.15	66.88	74.13	Area	1	101.250	2.36	.128
SD	4.74	7.95	3.93	8.37	Sex	1	987.013	23.05	<.001
SE	1.06	1.78	.88	1.87	A × S	1	1.013	.02	.878
CV	6.83	10.44	5.88	11.29	Error	76	42.816		
n	20	20	20	20					
Length of digit one									
Mean	14.30	14.25	14.25	14.55	Area	1	.313	.24	.625
SD	1.08	1.07	1.29	1.10	Sex	1	.313	.24	.625
SE	.24	.24	.29	.25	A × S	1	.613	.47	.494
CV	7.55	7.51	9.05	7.56	Error	76	1.298		
n	20	20	20	20					
Length of digit three									
Mean	140.90	142.65	141.20	142.50	Area	1	.113	.00	.952
SD	4.41	6.83	5.35	5.35	Sex	1	46.513	1.51	.223
SE	.99	1.53	1.20	1.20	A × S	1	1.013	.03	.857
CV	3.13	4.79	3.79	3.75	Error	76	30.823		
n	20	20	20	20					
Length of digit four									
Mean	106.30	107.15	105.40	106.50	Area	1	12.013	.56	.455
SD	4.66	5.43	3.58	4.61	Sex	1	19.013	.89	.348
SE	1.04	1.22	.80	1.03	A × S	1	.313	.01	.904
CV	4.38	5.07	3.40	4.39	Error	76	21.297		
n	20	20	20	20					
Length of digit five									
Mean	98.65	100.05	97.95	99.45	Area	1	8.450	.42	.521
SD	3.72	5.95	3.63	4.33	Sex	1	42.050	2.07	.154
SE	.83	1.33	.81	.97	A × S	1	.050	.00	.961
CV	3.77	5.95	3.71	4.35	Error	76	20.308		
n	20	20	20	20					
Tibia length									
Mean	27.15	27.60	26.95	27.75	Area	1	.013	.01	.929
SD	1.76	1.14	1.05	.91	Sex	1	7.813	4.95	.029
SE	.39	.26	.21	.21	A × S	1	.613	.39	.535
CV	5.48	4.13	3.90	3.28	Error	76	1.579		
n	20	20	20	20					
Calcar length									
Mean	8.25	7.90	8.95	8.45	Area	1	7.813	8.80	.004
SD	.97	.91	.95	.95	Sex	1	3.613	4.07	.047
SE	.22	.20	.21	.21	A × S	1	.113	.13	.723
CV	11.76	11.52	10.61	11.24	Error	76	.888		
n	20	20	20	20					
Noseleaf length									
Mean	8.30	8.25	8.20	8.35	Area	1	.000	.00	1.000
SD	.66	1.07	.83	.59	Sex	1	.050	.08	.783
SE	.15	.24	.19	.13	A × S	1	.200	.31	.582
CV	7.95	12.97	10.12	7.07	Error	76	.654		
n	20	20	20	20					

Table 21.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Greatest length of skull									
Mean	31.30	31.33	30.87	31.16	Area	1	1.800	3.18	.079
SD	.62	.82	.79	.76	Sex	1	.512	.90	.345
SE	.14	.18	.18	.17	A × S	1	.338	.60	.442
CV	1.98	2.62	2.56	2.44	Error	76	.566		
n	20	20	20	20					
Condylobasal length									
Mean	27.87	27.90	27.33	27.68	Area	1	2.926	6.83	.001
SD	.53	.73	.60	.73	Sex	1	.703	1.64	.204
SE	.12	.16	.14	.16	A × S	1	.496	1.16	.285
CV	1.90	2.62	2.20	2.64	Error	76	.428		
n	20	20	20	20					
Zygomatic breadth									
Mean	19.07	18.87	18.66	18.91	Area	1	.722	2.32	.132
SD	.49	.75	.46	.49	Sex	1	.013	.04	.842
SE	.11	.17	.10	.11	A × S	1	1.013	3.25	.075
CV	2.57	3.97	2.47	2.59	Error	76	.311		
n	20	20	20	20					
Postorbital constriction									
Mean	6.73	6.71	6.72	6.68	Area	1	.010	.13	.720
SD	.25	.27	.32	.27	Sex	1	.021	.27	.605
SE	.06	.06	.07	.06	A × S	1	.003	.04	.842
CV	3.71	4.02	4.76	4.04	Error	76	.078		
n	20	20	20	20					
Mastoid breadth									
Mean	16.82	16.64	16.62	16.70	Area	1	.091	.48	.491
SD	.53	.46	.39	.34	Sex	1	.055	.29	.592
SE	.12	.10	.09	.08	A × S	1	.351	1.84	.179
CV	3.15	2.76	2.35	2.04	Error	76	.190		
n	20	20	20	20					
Breadth of braincase									
Mean	13.36	13.36	13.48	13.41	Area	1	.153	1.13	.290
SD	.27	.36	.45	.37	Sex	1	.028	.21	.650
SE	.06	.08	.10	.08	A × S	1	.021	.16	.694
CV	2.02	2.69	3.34	2.76	Error	76	.135		
n	20	20	20	20					
Rostral breadth									
Mean	10.17	10.02	9.82	10.02	Area	1	.780	5.12	.027
SD	.47	.42	.39	.26	Sex	1	.210	1.38	.244
SE	.10	.09	.09	.06	A × S	1	.210	1.38	.244
CV	4.64	4.15	3.97	2.59	Error	76	.153		
n	20	20	20	20					
Height of braincase									
Mean	15.77	15.52	15.64	15.56	Area	1	.046	.19	.661
SD	.48	.48	.56	.42	Sex	1	.553	2.33	.131
SE	.11	.11	.13	.09	A × S	1	.153	.64	.425
CV	3.04	3.09	3.58	2.70	Error	76	.237		
n	20	20	20	20					
Breadth across the upper molars									
Mean	13.75	13.57	13.57	13.69	Area	1	.018	.10	.754
SD	.49	.56	.31	.26	Sex	1	.024	.13	.715
SE	.12	.12	.07	.06	A × S	1	.438	2.47	.120
CV	3.56	4.13	2.28	1.90	Error	76	.177		
n	20	20	20	20					

Table 21.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Breadth across the upper canines					
Mean	8.83	8.85	8.81	9.00	Area	1	.079	.66	.419
SD	.49	.31	.29	.26	Sex	1	.209	1.75	.190
SE	.12	.07	.06	.06	A × S	1	.129	1.08	.302
CV	5.55	3.50	3.29	2.89	Error	74	.119		
n	18	20	20	20					
				Length of the maxillary toothrow					
Mean	10.99	11.03	10.92	11.10	Area	1	.000	.00	.978
SD	.37	.33	.27	.29	Sex	1	.249	2.53	.116
SE	.09	.07	.06	.06	A × S	1	.101	1.02	.315
CV	3.37	2.99	2.47	2.61	Error	74	.098		
n	18	20	20	20					
				Length of the upper molariform toothrow					
Mean	9.03	9.07	8.95	9.11	Area	1	.009	.12	.731
SD	.30	.24	.30	.27	Sex	1	.170	2.21	.141
SE	.07	.05	.07	.06	A × S	1	.074	.96	.330
CV	3.32	2.65	3.35	2.96	Error	76	.077		
n	18	20	20	20					
				Width of the widest molar					
Mean	4.70	4.06	4.10	4.12	Area	1	.038	1.22	.272
SD	.18	.20	.17	.17	Sex	1	.000	.01	.917
SE	.04	.04	.04	.04	A × S	1	.002	.07	.787
CV	4.42	4.93	4.15	4.13	Error	74	.031		
n	18	20	20	20					
				Greatest length of the mandible					
Mean	21.60	21.66	21.10	21.48	Area	1	2.245	6.92	.010
SD	.44	.80	.44	.52	Sex	1	.968	2.98	.088
SE	.10	.18	.10	.12	A × S	1	.512	1.58	.213
CV	2.04	3.69	2.09	2.42	Error	76	.324		
n	20	20	20	20					
				Length of the mandibular toothrow					
Mean	12.19	12.22	11.98	12.32	Area	1	.069	.47	.495
SD	.33	.48	.40	.29	Sex	1	.670	4.58	.036
SE	.08	.11	.09	.06	A × S	1	.464	3.17	.079
CV	2.71	3.93	3.34	2.35	Error	76	.146		
n	18	20	20	20					
				Length of the coronoid process					
Mean	9.99	9.79	9.53	9.60	Area	1	2.113	11.06	.001
SD	.46	.50	.43	.34	Sex	1	.072	.38	.541
SE	.10	.11	.10	.08	A × S	1	.365	1.91	.171
CV	4.60	5.11	4.51	3.54	Error	76	.191		
n	20	20	20	20					

Numerous authors have published measurements of *D. rotundus* (see Swanepoel and Genoways, 1979) but only Cunha Vieira (1942) included Brazilian specimens. Individual variation was examined by Martinez and Villa-R (1940), however, the sexes were combined in their statistical analysis. Both Hershkovitz (1949) and Husson (1962) noted that males were smaller than females, but rigorous statistical analyses were not performed. Husson (1962) further suggested that differences among samples of *D. rotundus* from Suriname, Colombia, and Trinidad were not appreciable.

Table 22 summarizes the results of statistical analyses of individual, secondary sexual and geo-

Table 22.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Desmodus rotundus *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean	77.85	80.95	78.60	81.00	Area	1	1.445	.09	.760
SD	3.70	3.99	3.36	4.62	Sex	1	68.306	4.45	.040
SE	.83	.89	1.50	1.75	A × S	1	1.106	.07	.790
CV	4.75	4.93	4.27	5.70	Error	48	15.348		
n	20	20	20	20					
				Hindfoot length					
Mean	14.15	14.90	14.80	15.14	Area	1	1.800	3.60	.064
SD	.75	.64	.84	.69	Sex	1	2.697	5.39	.025
SE	.17	.14	.37	.26	A × S	1	.374	.75	.391
CV	5.30	4.30	5.68	4.56	Error	48	.500		
n	20	20	5	7					
				Ear length					
Mean	17.45	18.15	18.00	18.29	Area	1	1.062	.68	.414
SD	1.47	.59	1.41	1.80	Sex	1	2.194	1.41	.242
SE	.33	.13	.63	.68	A × S	1	.388	.25	.621
CV	8.42	3.25	7.83	9.84	Error	48	1.561		
n	20	20	5	7					
				Tragus length					
Mean	8.55	8.35	8.40	8.29	Area	1	.104	.21	.652
SD	.61	.59	.55	1.25	Sex	1	.223	.44	.509
SE	.14	.13	.25	.47	A × S	1	.017	.03	.857
CV	7.13	7.07	6.55	15.08	Error	48	.503		
n	20	20	5	7					
				Forearm length					
Mean	60.30	63.55	60.60	65.57	Area	1	12.169	3.04	.088
SD	1.49	1.93	2.41	3.05	Sex	1	152.627	38.14	<.001
SE	.33	.43	1.08	1.15	A × S	1	6.691	1.67	.202
CV	2.47	3.04	3.98	4.65	Error	48	4.001		
n	20	20	5	7					
				Weight					
Mean	39.78	44.58	43.50	47.43	Area	1	97.724	2.33	.133
SD	6.99	4.67	8.22	8.16	Sex	1	172.037	4.10	.048
SE	1.56	1.04	3.68	3.08	A × S	1	1.715	.04	.841
CV	17.57	10.48	18.90	17.20	Error	48	41.919		
n	20	20	5	7					
				Length of digit one					
Mean	16.85	17.80	17.80	17.86	Area	1	2.290	1.68	.201
SD	1.18	1.01	1.48	1.35	Sex	1	2.290	1.68	.201
SE	.26	.23	.66	.51	A × S	1	1.800	1.32	.256
CV	7.00	5.67	8.31	7.56	Error	48	1.363		
n	20	20	5	7					
				Length of digit three					
Mean	92.60	99.05	94.60	100.14	Area	1	21.600	1.11	.297
SD	4.84	3.87	4.39	4.60	Sex	1	324.774	16.69	<.001
SE	1.08	.87	1.97	1.74	A × S	1	1.858	.10	.759
CV	5.23	3.91	4.64	4.59	Error	48	19.454		
n	20	20	5	7					

Table 22.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of digit four					
Mean	75.80	80.50	76.40	81.71	Area	1	7.433	.85	.361
SD	2.63	3.00	2.70	3.82	Sex	1	226.452	25.95	<.001
SE	.59	.67	1.21	1.44	A × S	1	.852	.10	.756
CV	3.47	3.73	3.53	4.68	Error	48	8.726		
n	20	20	5	7					
				Length of digit five					
Mean	73.65	78.85	75.20	79.29	Area	1	8.904	.95	.334
SD	2.16	2.91	3.42	5.06	Sex	1	194.701	20.80	<.001
SE	.48	.65	1.53	1.91	A × S	1	2.804	.30	.567
CV	2.93	3.69	4.55	6.38	Error	48	9.361		
n	20	20	5	7					
				Tibia length					
Mean	27.90	29.35	29.00	30.71	Area	1	13.713	8.92	.004
SD	1.29	1.09	1.00	1.60	Sex	1	22.609	14.71	<.001
SE	.29	.24	.45	.61	A × S	1	.158	.10	.750
CV	4.62	3.71	3.45	5.21	Error	48	1.537		
n	20	20	5	7					
				Greatest length of skull					
Mean	23.89	24.47	23.80	24.50	Area	1	.005	.02	.901
SD	.49	.65	.89	.28	Sex	1	3.511	10.31	.002
SE	.11	.15	.40	.11	A × S	1	.031	.09	.765
CV	2.05	2.66	3.74	1.14	Error	47	.341		
n	20	20	5	6					
				Condylobasal length					
Mean	21.50	21.99	21.66	22.20	Area	1	.293	1.81	.185
SD	.43	.42	.37	.23	Sex	1	2.273	14.04	<.001
SE	.10	.09	.16	.09	A × S	1	.005	.03	.856
CV	2.00	1.91	1.71	1.04	Error	47	.162		
n	20	20	5	6					
				Zygomatic breadth					
Mean	12.36	12.63	12.62	12.65	Area	1	.174	2.04	.160
SD	.28	.31	.19	.35	Sex	1	.187	2.19	.146
SE	.06	.07	.09	.14	A × S	1	.118	1.39	.245
CV	2.27	2.45	1.51	2.77	Error	47	.085		
n	20	20	5	6					
				Postorbital constriction					
Mean	5.37	5.41	5.34	5.57	Area	1	.037	.72	.401
SD	.29	.28	.15	.25	Sex	1	.158	3.06	.087
SE	.06	.06	.07	.10	A × S	1	.071	1.37	.248
CV	5.40	5.18	2.81	4.49	Error	47	.052		
n	20	20	5	6					
				Mastoid breadth					
Mean	12.73	12.84	12.76	12.90	Area	1	.017	.24	.627
SD	.29	.23	.15	.25	Sex	1	.134	1.85	.180
SE	.06	.06	.07	.10	A × S	1	.002	.03	.871
CV	2.28	2.18	1.18	1.94	Error	47	.072		
n	20	20	5	6					
				Breadth of braincase					
Mean	12.44	12.49	12.60	12.55	Area	1	.109	2.15	.149
SD	.20	.27	.14	.12	Sex	1	.000	.00	.974
SE	.05	.06	.06	.05	A × S	1	.019	.38	.539
CV	1.61	2.16	1.11	.96	Error	47	.050		
n	20	20	5	6					

Table 22.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Rostral breadth					
Mean	7.83	7.97	7.62	7.73	Area	1	.418	4.65	.036
SD	.25	.34	.35	.29	Sex	1	.132	1.47	.232
SE	.06	.08	.16	.12	A × S	1	.001	.01	.916
CV	3.19	4.27	4.59	3.75	Error	47	.090		
n	20	20	5	6					
				Height of braincase					
Mean	14.43	14.45	14.54	14.68	Area	1	.268	2.16	.149
SD	.37	.31	.11	.51	Sex	1	.057	.46	.501
SE	.08	.07	.05	.21	A × S	1	.033	.26	.611
CV	2.56	2.14	.76	3.47	Error	47	.124		
n	20	20	5	6					
				Breadth across the upper molars					
Mean	6.74	6.93	6.76	6.67	Area	1	.122	1.47	.232
SD	.26	.31	.17	.37	Sex	1	.022	.27	.608
SE	.06	.07	.08	.15	A × S	1	.178	2.15	.149
CV	3.86	4.47	2.51	5.55	Error	47	.083		
n	20	20	5	6					
				Breadth across the upper canines					
Mean	6.13	6.36	6.22	6.20	Area	1	.008	.21	.646
SD	.14	.20	.11	.32	Sex	1	.095	2.62	.112
SE	.03	.05	.05	.13	A × S	1	.134	3.71	.060
CV	2.28	3.14	1.77	5.16	Error	47	.036		
n	20	20	5	6					
				Length of the maxillary toothrow					
Mean	3.42	3.32	3.42	3.43	Area	1	.030	1.81	.185
SD	.09	.18	.08	.05	Sex	1	.014	.86	.358
SE	.02	.04	.04	.02	A × S	1	.025	1.52	.224
CV	2.63	5.42	2.34	1.46	Error	47	.017		
n	20	20	5	6					
				Length of the upper molariform toothrow					
Mean	1.33	1.31	1.36	1.40	Area	1	.033	3.37	.073
SD	.09	.11	.09	.11	Sex	1	.001	.13	.715
SE	.02	.02	.04	.05	A × S	1	.007	.65	.424
CV	6.77	8.40	6.62	7.86	Error	47	.010		
n	20	20	5	6					
				Width of the widest molar					
Mean	.99	.92	.92	.98	Area	1	.000	.01	.926
SD	.11	.09	.11	.12	Sex	1	.000	.01	.926
SE	.03	.02	.05	.05	A × S	1	.038	3.54	.066
CV	11.11	9.78	11.96	12.24	Error	47	.011		
n	20	20	5	6					
				Greatest length of the mandible					
Mean	15.06	15.49	15.50	15.67	Area	1	.802	5.56	.023
SD	.40	.38	.32	.35	Sex	1	.750	5.20	.027
SE	.09	.08	.15	.14	A × S	1	.143	.99	.324
CV	2.66	2.45	2.06	2.23	Error	47	.144		
n	20	20	5	6					
				Length of the mandibular toothrow					
Mean	4.53	4.55	4.52	4.60	Area	1	.004	.12	.734
SD	.13	.22	.30	.13	Sex	1	.019	.52	.473
SE	.03	.05	.14	.05	A × S	1	.009	.24	.623
CV	2.87	4.84	6.64	2.83	Error	47	.037		
n	20	20	5	6					

Table 22.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of the coronoid process					
Mean	5.72	6.15	5.80	6.00	Area	1	.011	.08	.777
SD	.34	.41	.27	.28	Sex	1	.851	6.59	.014
SE	.08	.09	.12	.12	A × S	1	.113	.88	.353
CV	5.94	6.67	4.66	4.67	Error	47	.129		
n	20	20	5	6					

graphic variation in populations of *D. rotundus* from the Northeast of Brazil. In all but one case, female mean values are larger than male mean values and statistically significant secondary sexual variation is revealed for seven external and four cranial characters. The observations of sexual dimorphism by Husson (1962) and Hershkovitz (1949) are statistically corroborated. Cerrado sample means are larger than Caatingas sample means for 19 characters, three of which exhibit statistically significant variation. Caatingas specimens have larger sample means than Cerrado specimens for only one character and the difference is not statistically significant. The failure to achieve statistical significance for geographic variation is probably due to the small sample sizes from the Cerrado. However, the consistent direction of the difference between sample means from the Caatingas and Cerrado does suggest the strong possibility of geographic variation within the Northeast of Brazil.

Diphylla ecaudata Spix, 1823

Ojasti and Linares (1971) recognize two subspecies of this sanguinivore; *D. e. ecaudata* is the designation appropriate for specimens from the Northeast of Brazil. This species was rare in the Caatingas and apparently absent from the Chapada do Araripe.

Among the authors cited by Swanepoel and Genoways (1979) for contributing knowledge to *D. ecaudata*'s morphometric biology, only Dobson (1878), Lima (1926), and Cunha Vieira (1942) reported measurements from Brazilian specimens. Two adult males and two adult females were collected in the Caatingas; selected morphological measurements (after Swanepoel and Genoways, 1979) are herein reported (Total length: 70, 66, 74, 69; tail length: —, —, —, —; hindfoot length: 15, 13, 15, 12; ear length: 15, 14, 15, 14; greatest length of skull: 21.2, 20.8, 21.2, 21.1; condylobasal length: 18.9, 18.0, 19.0, 18.7; zygomatic breadth: 12.2, 11.6, 12.1, 11.7; postorbital constriction: 6.8, 6.2, 6.5, 6.5; length of the maxillary toothrow: 3.0, 2.9, 3.0, 2.9; and breadth across the upper molars: 5.2, 4.9, 5.0, 5.0). Caatingas specimens are on the average smaller than the group of specimens from North and Central America whose measurements are reported by Swanepoel and Genoways (1979).

Family Natalidae

Natalus stramineus Gray, 1838

This aerial insectivore was apparently absent from the Caatingas and rare on the Chapada do Araripe. Because only two adult male specimens were captured, only select measurements (after Swanepoel and Genoways, 1979) are reported here (total length: 99, 104; tail length: 53, 57; hindfoot length: 9, 8; ear length: 15, 12; greatest length of skull: —, 16.0; condylobasal length: —, 14.9; zygomatic breadth: —, 8.7; postorbital constriction: —, 3.2; breadth of braincase: —, —; length of the maxillary toothrow: —, 6.7; breadth across the upper molars: —, 4.0). Specimens from the Northeast should be included in the subspecies *N. s. natalensis* because they were captured within the defined range of that subspecies (Goodwin, 1959) and because morphometric comparison with the type specimen indicates correspondence.

Family Furipteridae

Furipterus horrens (F. Cuvier, 1828)

This poorly known aerial insectivore was rare in the Caatingas where it was only captured on serrotes. It was apparently absent from all habitats on the Chapada do Araripe. Only one adult male and one adult female specimen were captured, hence selected measurements (after Swanepoel and Genoways,

1979) only will be reported here (total length: 84, 80; tail length: 45, 44; hindfoot length: 6, 6; ear length: 10, 9; greatest length of skull: 12.0, 12.0; condylobasal length: 11.0, 11.0; zygomatic breadth: 7.2, 7.2; postorbital constriction: 2.9, 2.8; breadth of braincase: 5.6, 5.8; length of the maxillary toothrow: 4.3, 4.6; breadth across the upper molars: 4.5, 4.6). Uieda et al. (1980) summarize and present new data on aspects of the biology of *F. horrens*; unfortunately, little can be added from this study.

Family Vespertilionidae

Myotis nigricans (Schinz, 1821)

This aerial insectivore was rare to common in both Caatingas and Cerrado biomes. Of the three subspecies currently recognized, populations from the Northeast should tentatively be assigned to the subspecies *M. n. nigricans* (LaVal, 1973); however, further systematic analyses are required to substantiate morphometric homogeneity within the subspecies. The sexes occurred in statistically indistinguishable proportions in both Caatingas and Cerrado biomes (Binomial Test $P > .05$). Only 39% of the 41 captured adult specimens from the Chapada do Araripe were males while 44% of the 260 captured specimens from the Cerrado were males. *M. n. nigricans* were frequently found roosting under the roofing tiles of abandoned buildings throughout the Northeast; however, individuals were not found in aggregations of any size.

Myers (1978) detected statistical differences in forearm length between specimens of male and female *M. nigricans* from Paraguay. Williams and Findley (1979) found male sample means consistently smaller than female sample means for six mensural characters; however, only head and body length exhibited statistically significant variation. Table 23 summarizes the results of statistical analyses of individual, secondary sexual and geographic variation in populations of *M. nigricans* from the Northeast of Brazil. Statistically significant secondary sexual variation occurs only for a single variable, weight; further, a pattern in the relationship between male and female mean values is not apparent. *M. nigricans* populations from the Northeast of Brazil clearly do not exhibit sexual dimorphism in external and cranial characters.

Populations of *M. nigricans* from Caatingas and Cerrado biomes do not exhibit appreciable geographic variation either. Only two characters, calcar length and length from the canine to the last molar in the mandible, exhibit statistically significant variation between Caatingas and Cerrado sites; and trends in mean value relationships are not apparent. The Caatingas and Cerrado populations are morphometrically homogeneous.

Eptesicus furinalis D'Orbigny and Gervais, 1847

This aerial insectivore was apparently absent from the Caatingas and rare on the Chapada do Araripe. Williams (1978) suggested that Caatingas specimens of *E. furinalis* are most closely allied with the subspecies *E. f. chapmani*; however, the specimens he utilized were actually a subsample of the specimens caught in Cerrado habitats of the Chapada do Araripe.

Samples are small but sufficient for analyzing individual and secondary sexual variation by statistical methods; the results are summarized in Table 24. Females have larger sample means than males for ten external and 14 cranial characters. Males have larger sample means than females for five variables. Three of the characters (forearm length, weight, and greatest length of the maxillary) exhibited statistically significant secondary sexual variation; in all three cases, the male mean value was larger than the female mean value. Further, Williams (1978) suggested that sexual dimorphism existed in the Chapada population of *E. furinalis* based upon a multivariate analysis of variation.

Lasiurus borealis (Muller, 1776)

This aerial insectivore was rare on the Chapada do Araripe and apparently absent from the Caatingas. Its range extends from northern North America to southern South America.

Samples of *L. borealis* are small, but of sufficient size to attempt statistical analyses of individual and secondary sexual variation (Table 25). Females have larger sample means than males for all characters except postorbital constriction. Statistically significant secondary sexual variation was evidenced by four external and six cranial characters. Sexual dimorphism for size with females larger than males is strongly indicated by the data. This corroborates the findings of Williams and Findley (1979) which also indicated sexual dimorphism.

Lasiurus ega (Gervais, 1856)

This aerial insectivore was present but rare in both Caatingas and Cerrado biomes. According to the subspecies ranges suggested by Handley (1960), specimens from the Northeast of Brazil should be

Table 23.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Myotis nigricans *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	80.65	81.90	81.44	81.75	Area	1	1.912	.19	.661
SD	2.61	3.95	2.61	3.09	Sex	1	11.489	1.17	.283
SE	.58	.88	.65	.69	A × S	1	4.136	.42	.519
CV	3.24	4.82	3.20	3.78	Error	72	9.834		
n	20	20	16	20					
Tail length									
Mean	35.95	35.45	35.44	35.30	Area	1	2.065	.22	.641
SD	2.50	2.74	2.76	3.98	Sex	1	1.913	.20	.653
SE	.56	.61	.69	.89	A × S	1	.618	.07	.798
CV	6.95	7.73	7.79	11.27	Error	72	9.389		
n	20	20	16	20					
Hindfoot length									
Mean	5.95	6.00	5.94	5.90	Area	1	.060	.56	.458
SD	.39	0	.25	.45	Sex	1	.001	.01	.934
SE	.09	0	.06	.10	A × S	1	.036	.34	.563
CV	6.55	0	4.21	7.63	Error	72	.107		
n	20	20	16	20					
Ear length									
Mean	12.35	12.20	12.31	12.25	Area	1	.001	.00	.973
SD	.75	.77	.79	.85	Sex	1	.213	.34	.561
SE	.17	.17	.20	.19	A × S	1	.036	.06	.811
CV	6.07	6.31	6.42	6.94	Error	72	.624		
n	20	20	16	20					
Tragus length									
Mean	7.65	7.55	7.81	7.80	Area	1	.801	2.29	.134
SD	.59	.51	.54	.70	Sex	1	.060	.17	.681
SE	.13	.11	.14	.16	A × S	1	.036	.10	.749
CV	7.71	6.75	6.91	8.97	Error	72	.349		
n	20	20	16	20					
Forearm length									
Mean	34.40	33.85	34.00	33.80	Area	1	.953	.77	.382
SD	1.14	.88	1.32	1.11	Sex	1	2.647	2.15	.147
SE	.26	.20	.33	.25	A × S	1	.577	.47	.456
CV	3.31	2.60	3.88	3.28	Error	72	1.230		
n	20	20	16	20					
Weight									
Mean	4.50	4.95	4.34	4.88	Area	1	.252	.85	.359
SD	.46	.63	.44	.60	Sex	1	4.531	15.35	<.001
SE	.10	.14	.11	.14	A × S	1	.031	.11	.747
CV	10.22	12.73	10.14	12.30	Error	72	.295		
n	20	20	16	20					
Length of digit one									
Mean	4.95	4.70	4.63	4.70	Area	1	.497	1.70	.197
SD	.51	.47	.62	.57	Sex	1	.144	.49	.485
SE	.11	.11	.16	.13	A × S	1	.497	1.70	.197
CV	10.30	10.00	13.39	12.13	Error	72	.293		
n	20	20	16	20					

Table 23.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	56.50	56.65	56.06	56.60	Area	1	1.118	.16	.694
SD	2.91	2.23	2.59	2.91	Sex	1	2.224	.31	.580
SE	.65	.50	.65	.65	A × S	1	.707	.10	.755
CV	5.15	3.94	4.62	5.14	Error	72	7.185		
n	20	20	16	20					
Length of digit four									
Mean	47.45	47.10	45.88	47.30	Area	1	8.897	1.51	.223
SD	2.37	2.17	2.47	2.68	Sex	1	5.438	.92	.340
SE	.53	.49	.62	.60	A × S	1	14.827	2.51	.117
CV	4.99	4.61	5.38	5.67	Error	72	5.899		
n	20	20	16	20					
Length of digit five									
Mean	44.45	44.15	43.88	43.85	Area	1	3.603	.78	.381
SD	1.54	2.01	2.16	2.74	Sex	1	.497	.11	.744
SE	.34	.45	.54	.61	A × S	1	.356	.08	.783
CV	3.46	4.55	4.92	6.25	Error	72	.636		
n	20	20	16	20					
Tibia length									
Mean	15.45	15.00	15.19	15.20	Area	1	.018	.03	.869
SD	.95	.80	.75	.77	Sex	1	.901	1.33	.252
SE	.21	.18	.19	.17	A × S	1	1.007	1.49	.226
CV	6.15	5.33	4.94	5.07	Error	72	.675		
n	20	20	16	20					
Calcar length									
Mean	12.60	12.50	12.44	11.50	Area	1	6.360	3.99	.050
SD	1.27	1.47	1.26	1.00	Sex	1	5.065	3.18	.079
SE	.29	.33	.32	.22	A × S	1	3.301	2.07	.154
CV	10.08	11.76	10.13	8.70	Error	72	1.594		
n	20	20	16	20					
Greatest length of skull									
Mean	13.46	13.50	13.49	13.51	Area	1	.006	.06	.803
SD	.35	.29	.24	.30	Sex	1	.013	.14	.705
SE	.08	.07	.06	.07	A × S	1	.001	.01	.915
CV	2.60	2.15	1.78	2.22	Error	69	.092		
n	20	20	14	19					
Condylobasal length									
Mean	12.81	12.75	12.79	12.71	Area	1	.010	.11	.736
SD	.34	.24	.28	.29	Sex	1	.090	1.07	.305
SE	.08	.06	.08	.07	A × S	1	.002	.03	.872
CV	2.65	1.88	2.19	2.28	Error	69	.085		
n	20	20	14	19					
Zygomatic breadth									
Mean	8.26	8.30	8.36	8.32	Area	1	.054	1.67	.202
SD	.17	.16	.24	.18	Sex	1	.000	.00	.952
SE	.04	.04	.08	.05	A × S	1	.024	.73	.397
CV	2.06	1.93	2.87	2.16	Error	55	.032		
n	20	19	8	12					
Postorbital constriction									
Mean	3.29	3.25	3.29	3.25	Area	1	.000	.02	.878
SD	.09	.14	.12	.11	Sex	1	.028	2.11	.151
SE	.02	.03	.03	.02	A × S	1	.000	.02	.878
CV	2.74	4.31	3.65	3.38	Error	71	.013		
n	20	20	15	20					

Table 23.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Mastoid breadth					
Mean	6.94	6.93	6.93	6.92	Area	1	.002	.07	.794
SD	.12	.15	.10	.18	Sex	1	.002	.08	.777
SE	.03	.03	.03	.04	A × S	1	.000	.02	.887
CV	1.73	2.16	1.44	2.60	Error	68	.022		
n	20	20	13	19					
				Breadth of braincase					
Mean	6.48	6.40	6.38	6.42	Area	1	.029	1.09	.300
SD	.21	.13	.11	.17	Sex	1	.006	.24	.628
SE	.05	.03	.03	.04	A × S	1	.067	2.53	.116
CV	3.24	2.03	1.72	2.65	Error	69	.027		
n	20	20	14	19					
				Rostral breadth					
Mean	3.50	3.49	3.42	3.50	Area	1	.020	1.00	.322
SD	.11	.13	.13	.18	Sex	1	.020	1.00	.322
SE	.02	.03	.03	.04	A × S	1	.042	2.13	.149
CV	3.14	3.72	3.80	5.14	Error	71	.020		
n	20	20	15	20					
				Height of braincase					
Mean	6.67	6.70	6.59	6.58	Area	1	.168	3.61	.062
SD	.20	.20	.17	.26	Sex	1	.003	.06	.812
SE	.05	.05	.05	.06	A × S	1	.003	.06	.806
CV	3.00	2.99	2.58	3.95	Error	68	.046		
n	20	20	13	19					
				Breadth across the upper molars					
Mean	5.41	5.41	5.35	5.34	Area	1	.076	2.89	.094
SD	.18	.15	.17	.15	Sex	1	.001	.03	.854
SE	.04	.03	.05	.03	A × S	1	.000	.00	.956
CV	3.33	2.77	3.18	2.81	Error	68	.026		
n	20	20	13	19					
				Breadth across the upper canines					
Mean	3.42	3.48	3.46	3.48	Area	1	.008	.41	.526
SD	.15	.15	.10	.13	Sex	1	.024	1.30	.259
SE	.03	.03	.03	.03	A × S	1	.005	.27	.606
CV	4.39	4.31	2.89	3.74	Error	67	.019		
n	20	20	12	19					
				Length of the maxillary toothrow					
Mean	5.09	5.07	5.11	5.07	Area	1	.005	.28	.599
SD	.19	.11	.14	.10	Sex	1	.019	.98	.325
SE	.04	.02	.04	.02	A × S	1	.003	.14	.709
CV	3.73	2.17	2.74	1.97	Error	70	.019		
n	20	20	14	20					
				Length of the upper molariform toothrow					
Mean	4.22	4.21	4.16	4.22	Area	1	.010	.43	.512
SD	.20	.11	.18	.12	Sex	1	.015	.63	.429
SE	.04	.02	.05	.03	A × S	1	.021	.87	.354
CV	4.74	2.61	4.33	2.84	Error	70	.024		
n	20	20	14	20					
				Width of the widest molar					
Mean	1.58	1.56	1.58	1.57	Area	1	.001	.12	.726
SD	.06	.08	.11	.08	Sex	1	.003	.37	.543
SE	.01	.02	.03	.02	A × S	1	.000	.03	.868
CV	3.80	5.13	6.96	5.10	Error	70	.007		
n	20	20	14	20					

Table 23.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Greatest length of the mandible									
Mean	9.80	9.82	9.84	9.86	Area	1	.033	.44	.510
SD	.30	.26	.27	.27	Sex	1	.007	.10	.757
SE	.07	.06	.07	.06	A × S	1	.000	.00	.998
CV	3.06	2.65	2.74	2.74	Error	68	.075		
n	20	20	14	19					
Length of the mandibular toothrow									
Mean	5.55	5.55	5.43	5.43	Area	1	.279	7.75	.007
SD	.21	.15	.17	.22	Sex	1	.000	.00	.961
SE	.05	.03	.05	.05	A × S	1	.000	.00	.961
CV	3.78	2.70	3.13	4.05	Error	68	.036		
n	20	20	13	19					
Length of the coronoid process									
Mean	3.00	3.02	2.91	3.01	Area	1	.045	3.03	.086
SD	.14	.10	.10	.13	Sex	1	.055	3.73	.058
SE	.03	.02	.03	.03	A × S	1	.030	2.01	.161
CV	4.67	3.31	3.44	4.32	Error	67	.015		
n	20	20	13	18					

Table 24.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Eptesicus furinalis *males and females from the Cerrado biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean			96.71	97.40	Sex	1	2.244	.18	.678
SD			3.25	3.68	Within	20	12.651		
SE			1.23	.95					
CV			3.36	3.78					
n			7	15					
Tail length									
Mean			39.14	38.33	Sex	1	3.127	.38	.544
SD			1.35	3.31	Within	20	8.210		
SE			.51	.85					
CV			3.45	8.64					
n			7	15					
Hindfoot length									
Mean			7.00	6.33	Sex	1	2.121	2.77	.112
SD			.82	.90	Within	20	.767		
SE			.31	.23					
CV			11.71	14.22					
n			7	15					
Ear length									
Mean			13.57	13.67	Sex	1	.043	.07	.799
SD			.98	.72	Within	20	.652		
SE			.37	.19					
CV			7.22	5.27					
n			7	15					

Table 24.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Tragus length					
Mean			8.14	8.53	Sex	1	.728	1.00	.330
SD			.90	.83	Within	20	.730		
SE			.34	.22					
CV			11.06	8.73					
n			7	15					
				Forearm length					
Mean			38.86	40.13	Sex	1	7.773	5.44	.030
SD			1.35	1.13	Within	20	1.430		
SE			.51	.29					
CV			3.47	2.82					
n			7	15					
				Weight					
Mean			8.36	9.53	Sex	1	6.603	5.37	.031
SD			.69	1.25	Within	20	1.230		
SE			.26	.32					
CV			8.25	13.12					
n			7	15					
				Length of digit one					
Mean			4.86	5.40	Sex	1	1.407	3.33	.083
SD			.69	.63	Within	20	.423		
SE			.26	.16					
CV			14.20	11.67					
n			7	15					
				Length of digit three					
Mean			67.14	68.80	Sex	1	13.107	2.59	.123
SD			2.34	2.21	Within	20	5.063		
SE			.88	.57					
CV			3.48	3.21					
n			7	15					
				Length of digit four					
Mean			55.86	57.07	Sex	1	6.982	2.50	.129
SD			1.68	1.67	Within	20	2.790		
SE			.63	.43					
CV			3.01	2.93					
n			7	15					
				Length of digit five					
Mean			49.29	49.87	Sex	1	1.611	.75	.398
SD			1.38	1.51	Within	20	2.158		
SE			.52	.39					
CV			2.80	3.03					
n			7	15					
				Tibia length					
Mean			16.00	16.27	Sex	1	.339	.30	.592
SD			0	1.28	Within	20	1.147		
SE			0	.33					
CV			0	7.87					
n			7	15					
				Calcar length					
Mean			12.57	12.87	Sex	1	.416	.28	.601
SD			1.27	1.19	Within	20	1.472		
SE			.48	.30					
CV			10.10	9.25					
n			7	15					

Table 24.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Greatest length of skull					
Mean			14.88	14.84	Sex	1	.010	.11	.746
SD			.33	.28	Within	18	.088		
SE			.13	.08					
CV			2.22	1.89					
n			6	14					
				Condylobasal length					
Mean			14.38	14.39	Sex	1	.000	.00	.993
SD			.28	.30	Within	17	.086		
SE			.11	.08					
CV			1.95	2.08					
n			6	13					
				Zygomatic breadth					
Mean			10.52	10.56	Sex	1	.005	.08	.787
SD			.20	.30	Within	13	.072		
SE			.08	.10					
CV			1.90	2.84					
n			6	9					
				Postorbital constriction					
Mean			3.59	3.64	Sex	1	.014	.56	.464
SD			.17	.16	Within	20	.025		
SE			.06	.04					
CV			4.74	4.40					
n			7	15					
				Mastoid breadth					
Mean			8.25	8.35	Sex	1	.040	1.01	.327
SD			.15	.21	Within	19	.040		
SE			.06	.06					
CV			1.82	2.51					
n			6	15					
				Breadth of braincase					
Mean			7.12	7.25	Sex	1	.080	3.57	.074
SD			.15	.15	Within	19	.022		
SE			.06	.04					
CV			2.11	2.07					
n			6	15					
				Rostral breadth					
Mean			4.69	4.83	Sex	1	.104	2.31	.145
SD			.25	.19	Within	20	.045		
SE			.10	.05					
CV			5.33	3.93					
n			7	15					
				Height of braincase					
Mean			7.42	7.47	Sex	1	.013	.18	.674
SD			.31	.24	Within	18	.069		
SE			.13	.07					
CV			4.18	3.21					
n			6	14					
				Breadth across the upper molars					
Mean			6.46	6.51	Sex	1	.015	.46	.505
SD			.10	.21	Within	20	.033		
SE			.04	.05					
CV			1.55	3.23					
n			7	15					

Table 24.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Breadth across the upper canines									
Mean			4.61	4.80	Sex	1	.161	2.30	.146
SD			.20	.29	Within	19	.070		
SE			.07	.08					
CV			4.34	6.04					
n			7	14					
Length of the maxillary toothrow									
Mean			5.63	5.65	Sex	1	.003	.06	.810
SD			.10	.19	Within	20	.028		
SE			.04	.05					
CV			1.78	3.36					
n			7	15					
Length of the upper molariform toothrow									
Mean			4.53	4.51	Sex	1	.001	.06	.810
SD			.15	.13	Within	20	.019		
SE			.06	.03					
CV			3.31	2.88					
n			7	15					
Width of the widest molar									
Mean			1.94	2.00	Sex	1	.016	2.27	.147
SD			.08	.09	Within	20	.007		
SE			.03	.02					
CV			2.29	4.50					
n			7	15					
Greatest length of the mandible									
Mean			11.43	11.79	Sex	1	.635	9.05	.007
SD			.16	.30	Within	20	.070		
SE			.06	.08					
CV			1.40	2.54					
n			7	15					
Length of the mandibular toothrow									
Mean			6.13	6.20	Sex	1	.024	.66	.425
SD			.18	.20	Within	20	.037		
SE			.07	.05					
CV			2.94	3.23					
n			7	15					
Length of the coronoid process									
Mean			4.39	4.42	Sex	1	.006	.19	.668
SD			.17	.17	Within	20	.030		
SE			.06	.05					
CV			3.87	3.85					
n			7	15					

considered *L. e. argentinus*. However, he should have used the appellation *L. e. caudatus* (based upon a specimen from Pernambuco) which he puts in synonymy with *L. e. argentinus*, though it (*caudatus*) is the older name (Koopman, in litt.).

The morphometric data are pooled from the Caatingas and Cerrado biomes because the samples from each area alone are too small to perform statistical analyses. Table 26 summarizes the results of a statistical analysis of individual and secondary sexual variation in pooled samples. Only a single variable, forearm length, exhibits statistically significant secondary sexual variation. Females tended to have larger sample means than males, especially for ex-

Table 25.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Lasiurus borealis *males and females from the Cerrado biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean			99.67	105.53	Sex	1	64.222	2.78	.140
SD			3.98	6.43	Within	7	23.143		
SE			1.63	3.71					
CV			3.99	6.10					
n			6	3					
				Tail length					
Mean			41.00	46.00	Sex	1	50.000	7.29	.031
SD			2.90	1.73	Within	7	6.857		
SE			1.18	1.00					
CV			7.07	3.76					
n			6	3					
				Hindfoot length					
Mean			7.33	7.67	Sex	1	.222	.78	.407
SD			.52	.58	Within	7	.286		
SE			.21	.33					
CV			7.09	7.56					
n			6	3					
				Ear length					
Mean			10.17	10.67	Sex	1	.500	2.33	.171
SD			.41	.58	Within	7	.214		
SE			.17	.33					
CV			4.03	5.44					
n			6	3					
				Tragus length					
Mean			6.00	6.67	Sex	1	.889	2.33	.171
SD			.63	.58	Within	7	.381		
SE			.26	.33					
CV			10.50	8.70					
n			6	3					
				Forearm length					
Mean			38.83	40.67	Sex	1	6.722	4.09	.083
SD			1.17	1.53	Within	7	1.643		
SE			.48	.88					
CV			3.01	3.76					
n			6	3					
				Weight					
Mean			8.00	8.43	Sex	1	1.389	8.33	.023
SD			.45	.29	Within	7	.167		
SE			.18	.17					
CV			5.63	3.44					
n			6	3					
				Length of digit one					
Mean			8.50	9.33	Sex	1	1.389	4.49	.072
SD			.55	.58	Within	7	.310		
SE			.22	.33					
CV			6.47	6.22					
n			6	3					

Table 25.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Length of digit three					
Mean			77.17	82.67	Sex	1	60.500	5.07	.059
SD			2.93	4.51	Within	7	11.929		
SE			1.20	2.60					
CV			3.80	5.46					
n			6	3					
				Length of digit four					
Mean			59.00	64.67	Sex	1	64.222	15.68	.006
SD			2.37	.58	Within	7	4.095		
SE			.07	.33					
CV			4.02	.90					
n			6	3					
				Length of digit five					
Mean			50.33	53.33	Sex	1	18.000	.86	.384
SD			5.35	1.15	Within	7	20.857		
SE			2.19	.67					
CV			10.63	2.16					
n			6	3					
				Tibia length					
Mean			19.67	21.00	Sex	1	3.556	7.47	.029
SD			.82	0	Within	7	.476		
SE			.33	0					
CV			4.17	0					
n			6	3					
				Calcar length					
Mean			13.17	13.33	Sex	1	.056	.03	.879
SD			1.17	2.08	Within	7	2.214		
SE			.48	1.20					
CV			8.88	15.60					
n			6	3					
				Greatest length of skull					
Mean			11.27	11.70	Sex	1	.376	4.59	.070
SD			.08	.52	Within	7	.082		
SE			.03	.30					
CV			.71	4.44					
n			6	3					
				Condylobasal length					
Mean			10.87	11.33	Sex	1	.436	5.44	.052
SD			.16	.46	Within	7	.080		
SE			.07	.27					
CV			1.47	4.06					
n			6	3					
				Zygomatic breadth					
Mean			8.53	8.80	Sex	1	.142	7.47	.029
SD			.10	.20	Within	7	.019		
SE			.04	.12					
CV			1.17	2.27					
n			6	3					
				Postorbital constriction					
Mean			4.23	4.17	Sex	1	.009	.62	.456
SD			.10	.15	Within	7	.014		
SE			.04	.09					
CV			2.36	3.60					
n			6	3					

Table 25.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Mastoid breadth					
Mean			7.20	7.47	Sex	1	.142	6.79	.035
SD			.16	.12	Within	7	.021		
SE			.06	.07					
CV			2.22	1.61					
n			6	3					
				Breadth of braincase					
Mean			6.97	7.07	Sex	1	.020	.87	.381
SD			.10	.23	Within	7	.023		
SE			.04	.13					
CV			1.43	3.25					
n			6	3					
				Rostral breadth					
Mean			4.48	4.77	Sex	1	.161	4.41	.074
SD			.16	.25	Within	7	.036		
SE			.07	.15					
CV			3.57	5.24					
n			6	3					
				Height of braincase					
Mean			8.12	8.13	Sex	1	.001	.01	.924
SD			.27	.12	Within	7	.056		
SE			.11	.07					
CV			3.33	1.48					
n			6	3					
				Breadth across the upper molars					
Mean			5.27	5.70	Sex	1	.376	11.27	.012
SD			.21	.10	Within	7	.033		
SE			.08	.06					
CV			3.98	1.75					
n			6	3					
				Breadth across the upper canines					
Mean			4.35	4.87	Sex	1	.534	30.72	<.001
SD			.15	.06	Within	7	.017		
SE			.06	.03					
CV			3.45	1.23					
n			6	3					
				Length of the maxillary toothrow					
Mean			3.82	4.00	Sex	1	.067	4.34	.076
SD			.08	.20	Within	7	.016		
SE			.03	.12					
CV			2.09	5.00					
n			6	3					
				Length of the upper molariform toothrow					
Mean			3.13	3.13	Sex	1	.000	.00	1.000
SD			.10	.15	Within	7	.014		
SE			.04	.08					
CV			3.19	4.79					
n			6	3					
				Width of the widest molar					
Mean			1.38	1.40	Sex	1	.001	.08	.785
SD			.10	0	Within	7	.007		
SE			.04	0					
CV			7.25	0					
n			6	3					

Table 25.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Greatest length of the mandible					
Mean			8.45	8.93	Sex	1	.467	32.17	<.001
SD			.12	.11	Within	7	.015		
SE			.05	.07					
CV			1.42	1.23					
n			6	3					
				Length of the mandibular toothrow					
Mean			4.47	4.70	Sex	1	.109	6.73	.036
SD			.10	.17	Within	7	.016		
SE			.04	.10					
CV			2.24	3.62					
n			6	3					
				Length of the coronoid process					
Mean			2.65	2.80	Sex	1	.045	4.20	.080
SD			.11	.10	Within	7	.011		
SE			.04	.06					
CV			4.15	3.57					
n			6	3					

Table 26.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Lasiurus ega *males and females from both Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant (*P < .050*) secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean	121.50	122.50	120.00	134.00	Sex	1	27.075	1.19	.318
SD	2.12	2.89	—	—	Within	6	22.800		
SE	1.50	1.44	—	—					
CV	1.75	2.36	—	—					
n	2	4	1	1					
				Tail length					
Mean	57.00	52.50	50.00	52.00	Sex	1	9.633	.80	.404
SD	4.24	2.65	—	—	Within	6	11.978		
SE	3.00	1.32	—	—					
CV	7.44	5.05	—	—					
n	2	4	1	1					
				Hindfoot length					
Mean	8.00	7.00	8.00	8.00	Sex	1	1.200	2.57	.160
SD	0	.82	—	—	Within	6	.467		
SE	0	.41	—	—					
CV	0	11.71	—	—					
n	2	4	1	1					
				Ear length					
Mean	15.50	16.75	16.00	15.00	Sex	1	1.008	.28	.618
SD	2.12	2.22	—	—	Within	6	3.644		
SE	1.50	1.10	—	—					
CV	13.68	13.25	—	—					
n	2	4	1	1					

Table 26.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Tragus length									
Mean	9.50	9.75	10.00	9.00	Sex	1	.008	.03	.875
SD	.71	.50	—	—	Within	6	.311		
SE	.50	.25	—	—					
CV	7.47	5.13	—	—					
n	2	4	1	1					
Forearm length									
Mean	46.50	48.50	44.00	49.00	Sex	1	16.133	6.10	.049
SD	.71	1.92	—	—	Within	6	2.644		
SE	.50	.96	—	—					
CV	1.53	3.96	—	—					
n	2	4	1	1					
Weight									
Mean	13.75	15.00	13.00	14.50	Sex	1	3.675	.61	.465
SD	1.06	3.39	—	—	Within	6	6.033		
SE	.75	1.70	—	—					
CV	7.71	22.60	—	—					
n	2	4	1	1					
Length of digit one									
Mean	8.00	8.00	8.00	9.00	Sex	1	.075	.16	.702
SD	0	.82	—	—	Within	6	.467		
SE	0	.41	—	—					
CV	0	10.25	—	—					
n	2	4	1	1					
Length of digit three									
Mean	90.00	90.50	86.00	91.00	Sex	1	7.008	1.32	.294
SD	2.83	1.08	—	—	Within	6	5.311		
SE	2.00	1.04	—	—					
CV	3.14	2.99	—	—					
n	2	4	1	1					
Length of digit four									
Mean	70.00	71.25	67.00	71.00	Sex	1	9.075	3.68	.104
SD	1.41	1.50	—	—	Within	6	2.467		
SE	1.00	.75	—	—					
CV	2.01	2.11	—	—					
n	2	4	1	1					
Length of digit five									
Mean	57.50	58.00	55.00	58.00	Sex	1	3.333	1.87	.220
SD	.71	1.41	—	—	Within	6	1.778		
SE	.50	.71	—	—					
CV	1.23	2.43	—	—					
n	2	4	1	1					
Tibia length									
Mean	21.50	21.25	21.00	22.00	Sex	1	.008	.03	.875
SD	.71	.50	—	—	Within	6	.311		
SE	.50	.25	—	—					
CV	3.30	2.35	—	—					
n	2	4	1	1					
Calcar length									
Mean	17.00	17.25	18.00	19.00	Sex	1	.133	.05	.830
SD	2.83	1.26	—	—	Within	6	2.644		
SE	2.00	.63	—	—					
CV	16.65	7.30	—	—					
n	2	4	1	1					

Table 26.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Greatest length of skull									
Mean	15.00	15.13	14.90	15.50	Sex	1	.114	1.26	.313
SD	.57	.11	—	—	Within	5	.091		
SE	.40	.07	—	—					
CV	3.80	.73	—	—					
n	2	3	1	1					
Condylobasal length									
Mean	14.50	14.80	14.50	15.00	Sex	1	.210	4.57	.086
SD	.42	.10	—	—	Within	5	.046		
SE	.30	.06	—	—					
CV	2.90	.68	—	—					
n	2	3	1	1					
Zygomatic breadth									
Mean	10.55	10.83	10.60	10.80	Sex	1	.114	1.62	.260
SD	.07	.42	—	—	Within	5	.071		
SE	.05	.24	—	—					
CV	.66	3.88	—	—					
n	2	3	1	1					
Postorbital constriction									
Mean	4.75	4.58	4.60	4.30	Sex	1	.061	.47	.517
SD	.21	.47	—	—	Within	6	.128		
SE	.15	.23	—	—					
CV	4.42	10.26	—	—					
n	2	4	1	1					
Mastoid breadth									
Mean	8.75	8.90	8.70	8.60	Sex	1	.014	.41	.549
SD	.21	.17	—	—	Within	5	.035		
SE	.15	.10	—	—					
CV	2.42	1.91	—	—					
n	2	4	1	1					
Breadth of braincase									
Mean	8.20	8.23	8.40	8.10	Sex	1	.008	.09	.772
SD	.42	.31	—	—	Within	5	.081		
SE	.30	.18	—	—					
CV	5.12	3.77	—	—					
n	2	4	1	1					
Rostral breadth									
Mean	5.85	5.30	5.90	6.00	Sex	1	.263	1.14	.335
SD	.07	.62	—	—	Within	5	.231		
SE	.05	.36	—	—					
CV	1.20	11.70	—	—					
n	2	3	1	1					
Height of braincase									
Mean	8.95	8.90	9.20	8.80	Sex	1	.043	1.23	.317
SD	.21	.20	—	—	Within	5	.035		
SE	.15	.12	—	—					
CV	2.35	2.25	—	—					
n	2	3	1	1					
Breadth across the upper molars									
Mean	7.10	6.88	6.90	7.30	Sex	1	.010	.15	.710
SD	.14	.26	—	—	Within	6	.066		
SE	.10	.13	—	—					
CV	1.97	3.78	—	—					
n	2	4	1	1					

Table 26.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Breadth across the upper canines									
Mean	5.90	5.83	6.10	5.90	Sex	1	.023	.54	.496
SD	.14	.29	—	—	Within	5	.043		
SE	.10	.17	—	—					
CV	2.37	4.97	—	—					
n	2	3	1	1					
Length of the maxillary toothrow									
Mean	5.35	5.37	5.30	5.50	Sex	1	.008	.57	.484
SD	.07	.15	—	—	Within	5	.013		
SE	.05	.09	—	—					
CV	1.31	2.79	—	—					
n	2	3	1	1					
Length of the upper molariform toothrow									
Mean	4.15	4.27	4.20	4.50	Sex	1	.043	3.97	.103
SD	.07	.06	—	—	Within	5	.011		
SE	.05	.03	—	—					
CV	1.69	1.41	—	—					
n	2	3	1	1					
Width of the widest molar									
Mean	2.00	2.08	2.00	2.30	Sex	1	.027	2.38	.174
SD	0	.10	—	—	Within	6	.011		
SE	0	.05	—	—					
CV	0	4.81	—	—					
n	2	4	1	1					
Greatest length of the mandible									
Mean	11.10	11.63	11.30	10.60	Sex	1	.120	.77	.413
SD	.14	.13	—	—	Within	6	.156		
SE	.10	.06	—	—					
CV	1.26	1.11	—	—					
n	2	4	1	1					
Length of the mandibular toothrow									
Mean	6.15	6.20	6.20	5.80	Sex	1	.008	.14	.721
SD	.07	.27	—	—	Within	5	.053		
SE	.05	.15	—	—					
CV	1.13	4.35	—	—					
n	2	3	1	1					
Length of the coronoid process									
Mean	4.00	3.90	4.00	4.60	Sex	1	.003	.03	.865
SD	0	.25	—	—	Within	6	.095		
SE	0	.12	—	—					
CV	0	6.41	—	—					
n	2	4	1	1					

ternal characteristics, but the relationship between male and female sample means was not consistent enough to suggest the existence of sexual dimorphism in this species.

Family Molossidae

Molossops planirostris (Peters, 1865)

This fast-flying aerial insectivore was rare in the Caatingas and apparently absent from the Chapada do Araripe. The subspecific status of populations from the Northeast is uncertain. The three captured specimens were obtained from a hollow in a cut tree from Caatinga Alta.

Vizotto and Taddei (1976) statistically analyzed individual and secondary sexual variation in *M. planirostris.* They showed conclusively that males are larger than females on the average and that statistically significant secondary sexual variation occurs for most external and all cranial characters analyzed.

The three individuals captured from the Caatingas do not constitute a sufficiently large sample for statistical analyses so only selected measurements (after Swanepoel and Genoways, 1979) are presented here for an adult male and two adult female specimens (total length: 96, 93, 92; tail length: 22, 24, 26; hindfoot length: 5, 6, 6; ear length: 16, 17, 14; greatest length of skull: 16.1, 15.1, 15.4; condylobasal length: 15.8, 15.0, 14.9; zygomatic breadth: 11.2, 10.8, 11.0; postorbital constriction: 4.3, 4.1, 4.2; breadth of braincase: 7.8, 7.5, 7.8; length of the maxillary toothrow: 6.5, 6.3, 6.0; breadth across the upper molars: 7.7, 7.7, 7.7).

Molossops temminckii (Burmeister, 1854)

This molossid aerial insectivore was rare in the Caatingas and on the Chapada do Araripe. Based upon coloration characteristics and the distributional information summarized by Vizotto and Taddei (1976), specimens from northeastern Brazil should be considered *M. t. temminckii.*

Vizotto and Taddei (1976) are the only authors to analyze morphometric relations in *M. temminckii* via statistical techniques. None of the 17 external characters they examine exhibit statistically significant secondary sexual variation, and consistent mean value relations between males and females are not evident. On the other hand, males are consistently larger than females for cranial characters, but only two characters exhibit statistically significant differences.

In order to perform statistical analyses of individual and secondary sexual variation for specimens from the Northeast of Brazil, samples are combined from Caatingas and Cerrado biomes; the results of the analyses are summarized in Table 27. None of the external or cranial characters exhibit statistically significant secondary sexual variation, however, male sample means are consistently larger than those of females. Although data from the Northeast as well as that of Vizotto and Taddei (1976) fail to detect significant differences between males and females, both analyses strongly suggest sexual dimorphism with males larger than females, at least for cranial characters. Larger sample sizes or a multivariate analysis of variance would facilitate the detection of sexual dimorphism in this species.

Tadarida laticaudata (E. Geoffroy, 1805)

This fast-flying aerial insectivore was rare in the Caatingas and on the Chapada do Araripe. Samples from the Northeast of Brazil are small, so selected measurements (after Swanepoel and Genoways, 1979) of an adult male and female from the Caatingas and an adult male from the Chapada do Araripe are herein reported (total length: 96, 96, 107; tail length: 37, 39, 36; hindfoot length: 8, 8, 8; ear length: 18, 18, 20; greatest length of skull: 15.7, 16.2, —; condylobasal length: 14.9, 15.2, —; zygomatic breadth: 9.3, 9.3, —; postorbital constriction: 3.3, 3.2, —; breadth of braincase: 8.0, 7.7, —; length of the maxillary toothrow: 6.1, 6.2, —; and breadth across the upper molars: 6.6, 6.6, —).

Neoplatymops mattogrossensis (Cunha Vieira, 1942)

This small molossid aerial insectivore was common in rocky habitats and on serrotes in the Caatingas where it roosted in low-lying rock crevices. Approximately 46% of the 48 captured adult specimens from the Caatingas were males; as such, the sexes occurred in statistically indistinguishable proportions (Binomial Test, $P > .05$). *N. mattogrossensis* is absent from the Chapada do Araripe.

The biology of this species is poorly known. Other than the original description (Cunha Vieira, 1942) and the revision of flat-headed bats by Peterson (1965), only isolated distributional records appear in the literature (Handley, 1976; Sazima and Taddei, 1976). In a multivariate analysis of the family Molossidae, Freeman (1981) recently suggested allocating specimens in this species to the genus *Molossops*; however a consensus on this taxonomic question is not yet apparent. Both Peterson (1965) and Sazima and Taddei (1976) report mensural data for *N. mattogrossensis* but no one has statistically examined individual or secondary sexual variation in this species. Willig (unpublished ms.) has detected statistically significant geographic variation within and among populations of *Neoplatymops* from the Northeast of Brazil, southern Venezuela, and southwestern British Guiana.

Table 28 summarizes the results of a statistical analysis of individual and secondary sexual variation in this species. Like other molossids, *Neoplatymops* exhibits appreciable sexual dimorphism. Males have larger sample means than females for 12 of the 13 external characters. Males have larger sample means than females for all 16 cranial char-

Table 27.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Molossops temminckii *males and females from both Caatinga and Cerrado biomes. Due to small sample sizes, data from both biomes were combined to determine the existence of significant* (P < .050) *secondary sexual variation via a one-way analysis of variance (Model I) with replication.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Total length				
Mean	78.00	82.67	79.25	81.33	Sex	1	24.55	2.83	.127
SD	—	3.22	2.50	4.16	Within	9	8.67		
SE	—	1.86	1.25	2.40					
CV	—	3.90	3.15	5.11					
n	1	3	4	3					
					Tail length				
Mean	21.00	24.00	26.00	29.00	Sex	1	6.136	.43	.510
SD	—	3.46	3.74	1.72	Within	9	14.389		
SE	—	2.00	1.87	1.00					
CV	—	14.42	14.38	5.97					
n	1	3	4	3					
					Hindfoot length				
Mean	6.00	5.00	5.25	5.00	Sex	1	.436	.55	.479
SD	—	1.00	.96	1.00	Within	9	.800		
SE	—	.48	.48	.58					
CV	—	20.00	18.29	20.00					
n	1	3	4	3					
					Ear length				
Mean	12.00	12.67	13.00	12.33	Sex	1	.246	.51	.492
SD	—	.58	.82	.58	Within	9	.478		
SE	—	.33	.41	.33					
CV	—	4.58	6.31	4.70					
n	1	3	4	3					
					Tragus length				
Mean	3.00	2.67	2.25	3.33	Sex	1	.982	1.23	.297
SD	—	.58	.50	1.53	Within	9	.800		
SE	—	.33	.25	.88					
CV	—	21.72	22.22	45.94					
n	1	3	4	3					
					Forearm length				
Mean	33.00	31.67	31.50	31.00	Sex	1	.594	.87	.375
SD	—	.58	.58	1.00	Within	9	.682		
SE	—	.33	.29	.58					
CV	—	1.83	1.84	3.23					
n	1	3	4	3					
					Weight				
Mean	6.50	7.00	6.88	6.33	Sex	1	.049	.08	.787
SD	—	.50	1.03	.76	Within	9	.626		
SE	—	.29	.52	.44					
CV	—	7.14	14.97	12.01					
n	1	3	4	3					
					Length of digit one				
Mean	5.00	4.33	4.75	4.67	Sex	1	.246	.96	.353
SD	—	.58	.50	.58	Within	9	.256		
SE	—	.33	.25	.33					
CV	—	13.39	10.53	12.42					
n	1	3	4	3					

Table 27.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Length of digit three									
Mean	62.00	61.33	60.50	61.00	Sex	1	.367	.02	.880
SD	—	1.53	6.56	1.00	Within	9	15.293		
SE	—	.88	3.28	.58					
CV	—	2.49	10.84	1.64					
n	1	3	4	3					
Length of digit four									
Mean	52.00	51.00	51.50	51.00	Sex	1	.982	.32	.524
SD	—	1.73	2.52	1.00	Within	9	3.022		
SE	—	1.00	1.26	.58					
CV	—	3.39	4.89	1.96					
n	1	3	4	3					
Length of digit five									
Mean	38.00	35.67	36.50	35.67	Sex	1	3.503	1.42	.263
SD	—	1.53	1.92	1.53	Within	9	2.459		
SE	—	.88	.96	.80					
CV	—	4.29	5.26	4.29					
n	1	3	4	3					
Tibia length									
Mean	11.00	10.00	10.50	10.33	Sex	1	.512	2.27	.166
SD	—	0	.58	.58	Within	9	.226		
SE	—	0	.29	.33					
CV	—	0	5.52	5.61					
n	1	3	4	3					
Calcar length									
Mean	10.00	10.33	9.25	8.34	Sex	1	.012	.01	.941
SD	—	1.16	1.26	1.53	Within	9	2.059		
SE	—	.67	.63	.88					
CV	—	11.23	13.62	18.35					
n	1	3	4	3					
Greatest length of skull									
Mean	13.20	13.23	13.43	13.20	Sex	1	.060	.54	.485
SD	—	.31	.45	.36	Within	8	.112		
SE	—	.18	.26	.21					
CV	—	2.34	3.35	2.73					
n	1	3	3	3					
Condylobasal length									
Mean	13.10	13.10	13.10	12.83	Sex	1	.043	.24	.634
SD	—	.27	.66	.38	Within	8	.174		
SE	—	.15	.38	.22					
CV	—	2.06	5.04	2.96					
n	1	3	3	3					
Zygomatic breadth									
Mean	9.00	9.27	9.40	9.20	Sex	1	.008	.08	.784
SD	—	.06	.53	0	Within	7	.099		
SE	—	.03	.31	0					
CV	—	.65	5.64	0					
n	1	3	3	2					
Postorbital constriction									
Mean	3.70	3.67	3.70	3.70	Sex	1	.001	.06	.812
SD	—	.06	.10	.17	Within	8	.011		
SE	—	.03	.06	.10					
CV	—	1.63	2.70	4.59					
n	1	3	3	3					

Table 27.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Mastoid breadth					
Mean	8.80	8.67	8.90	8.40	Sex	1	.280	2.20	.177
SD	—	.15	.62	.20	Within	8	.128		
SE	—	.09	.36	.11					
CV	—	1.73	6.97	2.38					
n	1	3	3	3					
				Breadth of braincase					
Mean	6.90	7.13	7.17	7.17	Sex	1	.006	.12	.736
SD	—	.15	.32	.21	Within	8	.049		
SE	—	.09	.19	.12					
CV	—	2.10	4.46	2.93					
n	1	3	3	3					
				Rostral breadth					
Mean	5.10	5.20	5.03	4.90	Sex	1	.000	.00	1.000
SD	—	0	.21	.17	Within	8	.036		
SE	—	0	.12	.10					
CV	—	0	4.17	3.47					
n	1	3	3	3					
				Height of braincase					
Mean	6.50	6.83	7.17	6.67	Sex	1	.150	.68	.432
SD	—	.31	.61	.47	Within	8	.219		
SE	—	.18	.35	.27					
CV	—	4.54	8.51	7.05					
n	1	3	3	3					
				Breadth across the upper molars					
Mean	6.60	6.47	6.73	6.70	Sex	1	.033	.44	.524
SD	—	.15	.46	.10	Within	8	.074		
SE	—	.09	.27	.06					
CV	—	2.32	6.84	1.49					
n	1	3	3	3					
				Breadth across the upper canines					
Mean	3.70	3.83	4.00	3.73	Sex	1	.048	1.63	.237
SD	—	.06	.17	.21	Within	8	.030		
SE	—	.03	.10	.12					
CV	—	1.57	4.25	5.63					
n	1	3	3	3					
				Length of the maxillary toothrow					
Mean	5.50	5.13	5.17	5.20	Sex	1	.017	.73	.419
SD	—	.15	.15	0	Within	8	.030		
SE	—	.09	.09	0					
CV	—	2.92	2.90	0					
n	1	3	3	3					
				Length of the upper molariform toothrow					
Mean	4.50	4.40	4.33	4.33	Sex	1	.000	.02	.886
SD	—	.10	.06	.06	Within	8	.008		
SE	—	.06	.03	.03					
CV	—	2.27	1.39	1.39					
n	1	3	3	3					
				Width of the widest molar					
Mean	2.00	1.93	1.80	1.80	Sex	1	.001	.05	.826
SD	—	.06	.10	.10	Within	8	.013		
SE	—	.03	.06	.06					
CV	—	3.11	5.56	5.56					
n	1	3	3	3					

Table 27.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Greatest length of the mandible					
Mean	10.50	10.40	10.37	10.30	Sex	1	.006	.09	.776
SD	—	.36	.32	.17	Within	8	.069		
SE	—	.21	.19	.10					
CV	—	3.46	3.09	1.65					
n	1	3	3	3					
				Length of the mandibular toothrow					
Mean	5.90	5.80	5.93	5.80	Sex	1	.038	1.12	.321
SD	—	0	.25	.27	Within	8	.033		
SE	—	0	.15	.15					
CV	—	0	4.22	4.66					
n	1	3	3	3					
				Length of the coronoid process					
Mean	3.40	3.20	3.20	3.20	Sex	1	.006	.15	.713
SD	—	.10	.36	.20	Within	8	.041		
SE	—	.06	.21	.06					
CV	—	3.13	11.25	3.13					
n	1	3	3	3					

Table 28.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Neoplatymops mattogrossensis *males and females from the Caatinga biome. A one-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Total length					
Mean	79.14	76.81			Sex	1	64.621	4.19	.046
SD	3.12	4.49			Within	46	15.405		
SE	.67	.88							
CV	3.94	5.85							
n	22	26							
				Tail length					
Mean	25.50	25.65			Sex	1	.282	.04	.843
SD	2.84	2.50			Within	46	7.074		
SE	.61	.49							
CV	11.14	9.75							
n	22	26							
				Hindfoot length					
Mean	5.27	4.96			Sex	1	1.154	4.70	.040
SD	.55	.45			Within	46	.246		
SE	.12	.09							
CV	10.44	9.07							
n	22	26							
				Ear length					
Mean	13.36	13.12			Sex	1	.734	1.71	.197
SD	.58	.71			Within	46	.429		
SE	.12	.14							
CV	4.34	4.51							
n	22	26							

Table 28.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Tragus length									
Mean	3.14	3.04			Sex	1	.114	.21	.650
SD	.89	.60			Within	46	.556		
SE	.19	.12							
CV	28.34	19.74							
n	22	26							
Forearm length									
Mean	30.05	30.23			Sex	1	.409	.43	.514
SD	.90	1.03			Within	46	.947		
SE	.19	.20							
CV	3.00	3.41							
n	22	26							
Weight									
Mean	6.11	5.39			Sex	1	6.333	8.42	.006
SD	.64	1.02			Within	46	.753		
SE	.14	.20							
CV	10.47	18.92							
n	22	26							
Length of digit one									
Mean	5.54	5.16			Sex	1	1.739	3.15	.083
SD	.60	.85			Within	45	.551		
SE	.13	.17							
CV	10.83	16.47							
n	22	25							
Length of digit three									
Mean	55.22	54.16			Sex	1	13.330	6.30	.016
SD	1.11	1.70			Within	45	2.116		
SE	.24	.34							
CV	2.01	3.14							
n	22	25							
Length of digit four									
Mean	46.05	44.04			Sex	1	47.064	4.00	.052
SD	3.36	3.49			Within	45	11.776		
SE	.72	.70							
CV	7.30	7.92							
n	22	25							
Length of digit five									
Mean	33.64	32.96			Sex	1	5.353	1.91	.968
SD	1.59	1.74			Within	45	2.801		
SE	.34	.35							
CV	4.73	5.28							
n	22	25							
Tibia length									
Mean	10.27	10.04			Sex	1	.634	1.34	.254
SD	.63	.74			Within	45	.474		
SE	.14	.15							
CV	6.13	7.37							
n	22	25							
Calcar length									
Mean	9.09	8.60			Sex	1	2.820	2.77	.103
SD	1.15	.87			Within	45	1.018		
SE	.25	.17							
CV	12.65	10.12							
n	22	25							

Table 28.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Greatest length of skull									
Mean	14.11	13.47			Sex	1	4.485	38.05	<.001
SD	.35	.34			Within	41	.118		
SE	.08	.07							
CV	2.48	2.52							
n	21	22							
Condylobasal length									
Mean	13.91	13.25			Sex	1	4.738	49.40	<.001
SD	.31	.31			Within	41	.096		
SE	.07	.07							
CV	2.23	2.34							
n	21	22							
Zygomatic breadth									
Mean	9.76	9.31			Sex	1	1.290	20.31	<.001
SD	.25	.25			Within	24	.064		
SE	.07	.08							
CV	2.56	2.69							
n	15	11							
Postorbital constriction									
Mean	3.36	3.29			Sex	1	.059	7.01	.011
SD	.10	.08			Within	45	.008		
SE	.02	.02							
CV	2.98	2.43							
n	22	25							
Mastoid breadth									
Mean	9.60	9.06			Sex	1	2.143	19.92	<.001
SD	.40	.22			Within	28	.108		
SE	.10	.06							
CV	4.17	2.43							
n	16	14							
Breadth of braincase									
Mean	7.08	6.81			Sex	1	.768	14.58	<.001
SD	.28	.18			Within	41	.053		
SE	.06	.04							
CV	3.95	2.64							
n	21	22							
Rostral breadth									
Mean	4.33	3.88			Sex	1	2.431	49.88	<.001
SD	.22	.22			Within	45	.049		
SE	.05	.04							
CV	5.08	5.67							
n	22	25							
Height of braincase									
Mean	6.08	5.94			Sex	1	.203	3.19	.082
SD	.27	.24			Within	44	.064		
SE	.06	.05							
CV	4.44	4.04							
n	20	22							
Breadth across the upper molars									
Mean	6.54	6.40			Sex	1	.246	12.29	.001
SD	.13	.15			Within	44	.020		
SE	.03	.03							
CV	1.99	2.34							
n	21	25							

Table 28.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Breadth across the upper canines				
Mean	3.92	3.56			Sex	1	1.457	65.91	<.001
SD	.15	.15			Within	43	.022		
SE	.03	.03							
CV	3.83	4.21							
n	21	24							
					Length of the maxillary toothrow				
Mean	5.57	5.34			Sex	1	.607	28.30	<.001
SD	.16	.13			Within	44	.022		
SE	.04	.03							
CV	2.87	2.43							
n	21	25							
					Length of the upper molariform toothrow				
Mean	4.27	4.20			Sex	1	.058	2.84	.099
SD	.12	.16			Within	44	.021		
SE	.03	.03							
CV	2.81	3.81							
n	21	25							
					Width of the widest molar				
Mean	2.00	1.96			Sex	1	.014	2.31	.135
SD	.08	.08			Within	44	.006		
SE	.02	.02							
CV	4.00	4.08							
n	21	25							
					Greatest length of the mandible				
Mean	10.56	10.25			Sex	1	1.020	10.28	.003
SD	.33	.30			Within	42	.099		
SE	.07	.06							
CV	3.13	2.93							
n	22	22							
					Length of the maxillary toothrow				
Mean	5.91	5.69			Sex	1	.965	69.28	<.001
SD	.10	.13			Within	43	.014		
SE	.02	.03							
CV	1.69	2.28							
n	21	24							
					Length of the coronoid process				
Mean	3.76	3.46			Sex	1	.950	25.87	<.001
SD	.22	.15			Within	41	.037		
SE	.05	.03							
CV	5.85	4.34							
n	22	21							

acters and statistically significant differences were detected for all but three of these characters. *N. mattogrossensis* is clearly dimorphic with males being larger than females.

Molossus ater (E. Geoffroy, 1805)

This molossid aerial insectivore was rare in the Caatingas and was apparently absent from the Chapada do Araripe. Only one specimen, a juvenile, was captured from the Caatingas in December.

Molossus molossus (Pallas, 1766)

This fast-flying aerial insectivore was common in both Caatingas and Cerrado biomes. In both regions of the Northeast, *M. molossus* reached highest densities near abandoned man-made structures that it utilized for roosts. The sex ratios within Caatingas and Cerrado biomes were equal (Binomial Test, $P > .05$). Approximately 51% of the 135 captured adult specimens from the Chapada do Araripe were males; similarly, 50% of the 64 captured adult specimens from the Caatingas were males.

Samples are sufficiently large to permit a statistical analysis of individual, secondary sexual, and geographic variation in specimens of *M. molossus* from the Northeast of Brazil; the results are summarized in Table 29. Males have larger sample means than females for 26 of the 29 variables; six external and 16 cranial characters exhibit statistically significant secondary sexual variation. Like other molossids, *M. molossus* is highly dimorphic with males larger than females. Approximately half of the eharacters analyzed have larger sample means in the Caatingas than in the Cerrado, nine of that group exhibit statistically significant geographic variation. Only three characters have larger sample means in the Cerrado than in the Caatingas and only one of those variables exhibits statistically significant geographic variation. Geographic dimorphism is pronounced in the Northeast with Caatingas populations being larger on the average than Cerrado populations.

Eumops sp.

This molossid aerial insectivore was rare in the Caatingas and absent from the Chapada do Araripe. The single specimen from the Caatingas was taken in December; because of a damaged skull, specific status could not be ascertained with confidence.

MORPHOMETRICS

Throughout this study, morphometric variation has been analyzed using statistical techniques. Indeed, the consistent application of statistical criteria distinguishes this work from most other studies. Two interrelated questions naturally arise concerning such an approach: 1) does statistical significance mean biological significance? and 2) does biological significance mean statistical significance? The answer to both questions lies in exactly understanding the way in which biologists ask questions about the natural world.

Frequently, one is interested in various biological characteristics of a large population (for example, a species, subspecies, population, sex, or age group), but due to various limitations, only a small portion of the entire population can feasibly be examined. As such, samples are utilized to infer information about the populations from which they were derived. Further, samples are used in order to compare characteristics of two or more populations. Whenever samples are utilized to infer knowledge about larger populations, random error in selecting a sample affects the observed sample characteristics. The application of statistical techniques allows the biologist to ascertain with a prescribed level of confidence whether observed differences between samples could be due to chance or due to true differences in the populations from which they were derived. Clearly, perceived differences between samples which are caused by chance ought not to denote biological differences between the populations from which the samples were taken; the observed differences between the samples are due to chance. When statistical differences cannot be shown for a particular analysis, then the data do not support the existence of any population differences. The failure of a statistical test to detect a real difference between the populations is related to Type II error or β error (Sokal and Rohlf, 1969). Small samples make it difficult to detect real differences between populations; hence, very small differences between populations require large samples in order to be detected. Incorrectly ascribing differences to a population based upon sample characteristics is related to Type I error or α error (Sokal and Rohlf, 1969). Even when statistical significance is obtained, there is a known chance of being incorrect (that is, the populations may not be different at all). The exact chance of incorrectly asserting a difference between populations which does not, in fact, exist is equal to the level of significance of the statistical test (for example the 'P' level). Statistical differences detected with small samples are as valid as statistical differences detected with large samples because the probability of the differences being due to chance is defined by the Type I error.

In summary, statistical analysis is a method of considering the effects of chance in an investigation utilizing samples. Statistical significance indicates that the observed sample differences are *not* due to chance, while a failure to obtain statistical significance infers that any observed differences between samples are indistinguishable from chance variations. The biological meaning of the results is predicated upon a choice of characters with biological significance. If the character has biological meaning, then a significant statistical test reveals true differ-

Table 29.—*Summary statistics for external and cranial characters (mean; standard deviation, SD; standard error of the mean, SE; coefficient of variation, CV; sample size, n) of* Molossus molossus *males and females from both Caatinga and Cerrado biomes. A two-way analysis of variance (Model I) with replication is presented for each character. The existence of significant secondary sexual or geographic variation is indicated by* P *values less than or equal to .050.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
Total length									
Mean	108.20	102.90	106.30	101.75	Area	1	46.513	3.79	.055
SD	3.41	3.41	4.00	3.13	Sex	1	485.113	39.52	<.001
SE	.76	.76	.90	.70	A × S	1	2.813	.23	.634
CV	3.15	3.31	3.76	3.08	Error	76	12.276		
n	20	20	20	20					
Tail length									
Mean	37.60	33.95	38.10	35.70	Area	1	25.313	2.11	.151
SD	2.60	2.82	3.48	4.61	Sex	1	183.013	15.22	<.001
SE	.58	.63	.78	1.03	A × S	1	7.813	.65	.423
CV	6.91	8.31	9.13	12.91	Error	76	12.023		
n	20	20	20	20					
Hindfoot length									
Mean	7.45	6.75	6.95	7.00	Area	1	.313	.57	.453
SD	.69	.91	.83	.46	Sex	1	2.113	3.85	.053
SE	.15	.20	.19	.10	A × S	1	2.813	5.13	.026
CV	9.26	13.48	11.94	6.57	Error	76	.548		
n	20	20	20	20					
Ear length									
Mean	13.75	13.25	13.55	13.10	Area	1	.613	1.65	.203
SD	.55	.72	.61	.55	Sex	1	4.513	12.14	<.001
SE	.12	.16	.14	.12	A × S	1	.012	.03	.855
CV	4.00	5.43	4.50	4.20	Error	76	.372		
n	20	20	20	20					
Tragus length									
Mean	1.95	2.00	1.95	1.90	Area	1	.050	.67	.417
SD	.22	0	.22	.45	Sex	1	.000	.00	.999
SE	.05	0	.05	.10	A × S	1	.050	.67	.417
CV	11.28	0	11.28	23.68	Error	76	.075		
n	20	20	20	20					
Forearm length									
Mean	40.95	39.95	40.60	40.20	Area	1	.050	.04	.836
SD	.83	1.43	1.00	.95	Sex	1	9.800	8.47	.005
SE	.19	.32	.22	.21	A × S	1	1.800	1.56	.216
CV	2.03	3.58	2.46	2.36	Error	76	1.156		
n	20	20	20	20					
Weight									
Mean	16.67	15.15	15.98	13.33	Area	1	31.878	10.65	.002
SD	1.29	1.95	1.77	1.84	Sex	1	87.153	29.11	<.001
SE	.29	.44	.40	.41	A × S	1	6.328	2.11	.150
CV	7.74	12.87	11.07	13.80	Error	76	2.994		
n	20	20	20	20					
Length of digit one									
Mean	6.55	6.15	6.85	6.70	Area	1	3.613	9.08	.003
SD	.60	.49	.81	.57	Sex	1	1.513	3.80	.055
SE	.13	.11	.18	.13	A × S	1	.313	.79	.378
CV	9.16	7.97	11.82	8.51	Error	76	.398		
n	20	20	20	20					

Table 29.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Length of digit three				
Mean	77.85	76.35	76.00	75.40	Area	1	39.200	5.30	.024
SD	2.03	2.39	2.49	3.68	Sex	1	22.050	2.98	.088
SE	.46	.53	.56	.83	A × S	1	4.050	.55	.462
CV	2.61	3.13	3.28	4.88	Error	76	7.393		
n	20	20	20	20					
					Length of digit four				
Mean	58.15	57.60	57.05	56.50	Area	1	24.200	3.92	.050
SD	1.84	2.62	2.46	2.89	Sex	1	6.050	.98	.330
SE	.41	.59	.55	.65	A × S	1	.000	.00	1.000
CV	3.16	4.55	4.31	5.12	Error	76	6.175		
n	20	20	20	20					
					Length of digit five				
Mean	41.85	41.40	40.80	40.65	Area	1	16.200	5.67	.020
SD	1.66	2.09	1.47	1.46	Sex	1	1.800	.63	.430
SE	.37	.47	.33	.33	A × S	1	.450	.16	.693
CV	3.97	5.04	3.60	3.59	Error	76	2.857		
n	20	20	20	20					
					Tibia length				
Mean	15.20	14.55	15.30	14.85	Area	1	.800	2.44	.122
SD	.52	.69	.57	.49	Sex	1	6.050	18.47	<.001
SE	.12	.15	.13	.11	A × S	1	.200	.61	.437
CV	3.42	4.74	3.73	3.30	Error	76	.328		
n	20	20	20	20					
					Calcar length				
Mean	14.10	12.95	13.15	13.35	Area	1	1.513	.70	.405
SD	2.02	1.28	1.23	1.18	Sex	1	4.513	2.09	.152
SE	.45	.29	.27	.26	A × S	1	9.113	4.23	.043
CV	14.33	9.88	9.35	8.84	Error	76	2.160		
n	20	20	20	20					
					Greatest length of skull				
Mean	16.92	16.24	16.95	15.97	Area	1	.276	1.77	.187
SD	.36	.39	.45	.37	Sex	1	13.695	87.89	<.001
SE	.08	.09	.10	.08	A × S	1	.435	2.79	.099
CV	2.13	2.40	2.65	2.32	Error	76	.156		
n	20	20	20	20					
					Condylobasal length				
Mean	15.63	14.80	15.49	14.53	Area	1	.903	8.81	.004
SD	.35	.30	.35	.28	Sex	1	15.931	155.34	<.001
SE	.08	.07	.08	.06	A × S	1	.091	.89	.349
CV	2.24	2.03	2.26	1.93	Error	76	.103		
n	20	20	20	20					
					Zygomatic breadth				
Mean	11.00	10.53	10.86	10.35	Area	1	.496	10.26	.002
SD	.25	.20	.25	.18	Sex	1	4.851	100.31	<.001
SE	.05	.04	.05	.04	A × S	1	.006	.13	.723
CV	2.27	1.90	2.30	1.74	Error	76	.048		
n	20	20	20	20					
					Postorbital constriction				
Mean	3.56	3.52	3.62	3.48	Area	1	.001	.04	.833
SD	.18	.14	.17	.15	Sex	1	.171	6.81	.011
SE	.04	.03	.04	.03	A × S	1	.055	2.19	.143
CV	5.06	3.98	4.70	4.31	Error	76	.025		
n	20	20	20	20					

Table 29.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
				Mastoid breadth					
Mean	10.58	10.19	10.53	10.06	Area	1	.153	2.37	.128
SD	.22	.20	.31	.28	Sex	1	3.741	57.85	<.001
SE	.05	.05	.07	.06	A × S	1	.036	.56	.457
CV	2.08	1.96	2.94	2.78	Error	76	.065		
n	20	20	20	20					
				Breadth of braincase					
Mean	8.84	8.63	8.96	8.56	Area	1	.013	.32	.573
SD	.16	.16	.27	.18	Sex	1	1.861	47.69	<.001
SE	.04	.04	.06	.04	A × S	1	.200	5.13	.026
CV	1.81	1.85	3.01	2.10	Error	76	.039		
n	20	20	20	20					
				Rostral breadth					
Mean	5.17	5.09	5.28	4.99	Area	1	.001	.03	.870
SD	.17	.18	.21	.23	Sex	1	.66	16.84	<.001
SE	.04	.04	.05	.05	A × S	1	.210	5.31	.020
CV	3.29	3.54	3.98	4.61	Error	76			
n	20	20	20	20					
				Height of braincase					
Mean	9.77	9.24	9.63	9.03	Area	1	.578	8.72	.004
SD	.19	.25	.32	.25	Sex	1	.385	96.37	<.001
SE	.04	.06	.07	.06	A × S	1	.025	.37	.545
CV	1.94	2.71	3.32	2.77	Error	76	.066		
n	20	20	20	20					
				Breadth across the upper molars					
Mean	7.96	7.68	7.86	7.59	Area	1	.171	4.16	.045
SD	.16	.14	.29	.19	Sex	1	1.485	36.09	<.001
SE	.04	.03	.06	.04	A × S	1	.000	.00	.956
CV	2.01	1.82	3.69	2.50	Error	76	.041		
n	20	20	20	20					
				Breadth across the upper canines					
Mean	4.48	4.34	4.50	4.20	Area	1	.066	2.37	.128
SD	.14	.17	.20	.15	Sex	1	1.035	37.10	<.001
SE	.03	.04	.05	.03	A × S	1	.120	4.31	.041
CV	3.13	3.92	4.44	3.57	Error	76	.027		
n	20	20	20	20					
				Length of the maxillary toothrow					
Mean	6.22	5.97	6.25	5.96	Area	1	.001	.02	.896
SD	.11	.22	.20	.13	Sex	1	1.458	50.53	<.001
SE	.03	.05	.05	.03	A × S	1	.008	.28	.600
CV	1.77	3.69	3.20	2.18	Error	76	.029		
n	20	20	20	20					
				Length of the upper molariform toothrow					
Mean	4.87	4.78	4.93	4.74	Area	1	.003	.16	.689
SD	.12	.12	.19	.11	Sex	1	.378	19.58	<.001
SE	.03	.03	.04	.02	A × S	1	.055	2.85	.095
CV	2.46	2.51	3.85	2.32	Error	76	.019		
n	20	20	20	20					
				Width of the widest molar					
Mean	2.19	2.15	2.16	2.11	Area	1	.025	3.03	.086
SD	.11	.08	.07	.10	Sex	1	.041	5.01	.208
SE	.02	.02	.02	.02	A × S	1	.001	.06	.804
CV	5.02	3.72	3.24	4.74	Error	76	.008		
n	20	20	20	20					

Table 29.—*Continued.*

	Caatinga		Cerrado		Analysis of variance				
	♂♂	♀♀	♂♂	♀♀	Factor	df	MS	F	Significance
					Greatest length of the mandible				
Mean	12.04	11.51	12.02	11.19	Area	1	.613	10.10	.002
SD	.26	.23	.23	.26	Sex	1	9.248	152.43	<.001
SE	.06	.05	.05	.06	A × S	1	.481	7.92	.006
CV	2.16	2.00	1.91	2.32	Error	76	.061		
n	20	20	20	20					
					Length of the mandibular toothrow				
Mean	6.97	6.61	6.85	6.52	Area	1	.231	8.02	.006
SD	.14	.20	.18	.15	Sex	1	2.346	81.44	<.001
SE	.03	.05	.04	.03	A × S	1	.003	.11	.743
CV	2.01	3.03	2.63	2.30	Error	76	.029		
n	20	20	20	20					
					Length of the coronoid process				
Mean	4.57	4.34	4.50	4.29	Area	1	.066	1.61	.208
SD	.14	.13	.23	.28	Sex	1	.946	23.06	<.001
SE	.03	.03	.05	.06	A × S	1	.003	.08	.783
CV	3.06	2.93	5.11	6.53	Error	76	.041		
n	20	20	20	20					

ences in a biologically important characteristic. Failure to detect a statistically significant difference between samples infers that no real difference exists, or that if it does exist, the magnitude of the difference is too small to be detected by samples of the size utilized in the investigation.

Microgeographic Variation

Phenotypic variation within populations is the raw material upon which Natural Selection operates. However, only that portion of the phenotypic variation under genetic control is affected by Natural Selection. Unfortunately, a strong correlation between genic variation (estimated by electromorph heterozygosity) and morphological variation in mammalian populations has not been convincingly demonstrated (for a critical review, see Schnell and Selander, 1981); rather, it appears that genic, karyotypic and morphological evolution progress independently of each other. In part, the disparity between genic and morphological variation may be ascribed to regulator genes which greatly affect morphology but are not sampled by electrophoretic studies. Nonetheless, only by comparing variation in different populations can one determine how and to what extent the differences between individuals are molded into the differences that separate races and species (Simpson, 1944; Mayr, 1964; Yablokov, 1974). The consensus appears to be that the fields of population and quantitative genetics have not progressed in a direction to aid in the interpretation of these dynamics (Sokal, 1977). Two approaches to the problem have been suggested (Falconer, 1972)—first, new techniques in quantitative biology need to be developed in order to analyze patterns of natural variation; and second, a wider variety of characters and organisms need to be examined in order to decide which phenomena are general and which may be attributed to special circumstances. This study reveals the extent and magnitude of variation present within and between chiropteran populations in close geographic proximity. As such, it aids in illuminating general patterns of meristic variation present in natural populations, which both Mayr (1964) and Falconer (1972) suggested as a prerequisite for understanding evolutionary dynamics.

Nine bat species from the Brazilian Northeast were caught in sufficient quantities to permit statistical analyses of mean differences between populations from Caatingas and Cerrado biomes. The α level (Type I error) specified for each statistical test predetermines the probability of detecting differences between populations which occur because of chance alone. When 30 different morphometric characters are being statistically analyzed for mean differences, an average of 1.5 (.05 by 30) of the tests should incorrectly indicate that the means are different (if the tests are independent), when in fact they are not. Although some of the tests for some of the species may not be independent, this relation was utilized to determine the minimum number of statistical differences required to indicate the presence of real differences between Caatingas and Cerrado populations. If the assumption of independence is correct, the occurrence of 5 or more characters with statistically different means should occur less than one percent of the time due to chance alone. As a conservative measure then, only bat species with 5 or more significant differences were indicated as exhibiting geographic size dimorphism because pronounced correlation among the characters would increase the probability of mistakenly detecting significance. Five bat species did exhibit geographic size dimorphism for at least five morphometric characters. Caatingas populations were larger than Cerrado populations in four species—*C. perspicillata* (Table 16), *V. lineatus* (Table 18), *A. jamaicensis* (Table 20), and *M. molossus* (Table 29)—whereas *A. geoffroyi* (Table 15) exhibited geographic size dimorphism in which the Cerrado population was larger than the Caatingas population. These results caution against pooling data from different localities whenever possible in order to detect age- or sex-related differences. Further, they indicate that appreciable morphometric divergence can exist between populations of highly mobile species even when these populations inhabit adjacent areas. This implies that the amount of genetic communication between populations of these five species is quite low; Ehrlich and Raven (1969) considered this phenomenon to have impact upon the very definition of a biological species.

The utilization of statistical analysis can be a powerful tool in systematics, however, it should not form the sole basis upon which decisions concerning subspecific status are evaluated. Most populations will have at least slightly different parametric mean values because of the combined effects of mutation, migration, drift and natural selection acting upon local populations. The ability to detect these differences, even if they are slight, increases with sample size and the sensitivity of the utilized statistical procedure. Hence, the elucidation of statistical differences between populations often only confirms the original supposition that the samples were drawn from biological populations with different mean values. Clearly, the decision to apply subspecific designation to taxa must go beyond the detection of statistical differences because different populations within a subspecies could also exhibit such differences.

Secondary Sexual Variation

Although biologists have been interested in sexual dimorphism for many years, distinctions between the causes and functions of the phenomenon frequently are not evident. Polygamous mating systems, differential rates of maturation, unequal sex ratios, and differential resource utilization are often associated with species exhibiting dimorphism (Sealander, 1957; Daly and Wilson, 1978). A number of hypotheses which are not mutually exclusive have been developed to account for dimorphism in naturally occurring populations. The most prominent hypothesis, originally promulgated by Darwin (1859, 1871*a*, 1871*b*), suggests that one sex usually competes for reproductive access to the opposite sex. This results in different selective regimes acting on the competitors and on the objects of competition (see Trivers, 1972; Wilson, 1975; and Ralls, 1976 for reviews). Trivers (1972) hypothesized that the sex with the greatest parental investment will be in short supply and thereby be the object of competition. Due to their limited parental investment, male mammals should compete among themselves for the available females. Because large size often is beneficial in agonistic encounters, selection should differentially favor a larger size in males than in females. An alternative hypothesis suggests that sexual dimorphism reduces intraspecific competition for resources (Selander, 1966, 1972). Examples in the literature for skates (Feduccia and Slaughter, 1974), fish (Keast, 1966), lizards (Schoener, 1967, 1968), birds (Rand, 1952; Selander, 1966, 1972; Earhart and Johnson, 1970) and mammals (Kummer, 1971) have linked body size differences between males and females to differences in food consumption. In contrast, Mares and Williams (1977) found that different sized individuals within various granivorous rodent species did not consume different sized seeds. Moreover, Husar (1976) described dietary differences between male and female vespertilionid bats in which the differences in diet were in prey type rather than in prey size. Williams and Findley (1979) have shown that males and females in the species examined by Husar (1976) were not dimorphic. Thus, even if the sexes do differentially utilize resources, partitioning need not occur by prey size and sexual size dimorphism need not be the mechanism promoting the differences in diet.

If size variation can reduce intraspecific competition, it is not clear why greater individual variation, without sex associated differences, could not accomplish the same results. All other circumstances being equal, there is no *a priori* reason to expect males to be larger than females or females to be larger than males as a result of the differential niche hypothesis. At best, once other factors initially select for sex-related size differences, these differences could be accentuated by the benefits of reduced resource competition by niche partitioning among the sexes.

The observation that females are frequently larger than males has revealed the general inadequacy of both the sexual selection and niche partitioning hypotheses. Ralls (1976) advanees the "Big Mother" hypothesis to account for cases of sexual size dimorphism in which females are larger than males. For a variety of reasons, a larger female may be a more fit mother (that is, produce a larger number of successful progeny). Larger mothers may produce offspring with greater weights at birth; provide more or higher quality milk; more efficiently transport or defend young; or maintain homeothermic equilibrium conducive to embryonic development. Myers (1978) examined size variation in vespertilionid bats and only found dimorphism in which females were significantly larger than males. His analyses further showed that the wings of females were proportionately larger than those of males, with the degree of dimorphism correlated with litter size. Because of these observations, Myers (1978) suggested that the demands of motherhood were greater on species producing multiple young. Williams and Findley (1979) contend that the data considered by Myers (1978) were biased because monomorphic species with multiple young and highly dimorphic species with single young were excluded from the analyses. In their work (Williams and Findley, 1979), correlations between litter size and the degree of dimorphism were not evident. In accord with the work of Bogan (1975) and Findley and Traut (1970), they conclude that dimorphism in vespertilionids is probably related to differential thermoregulation rather than wing loading.

Within the Chiroptera, sexual dimorphism is primarily restricted to size, although the possession of dimorphic glands in the Emballonuridae and Molossidae is quite common (Bradbury, 1977). Sixteen species of bats from the Northeast of Brazil exhibited significant secondary sexual variation for eight or more morphometric characters. In approximately one-third of those cases, the sample means of females were larger than the sample means of the males (*P. macrotis,* Table 3; *G. soricina,* Table 13; *L. mordax,* Table 14; *V. lineatus,* Table 18; *A. concolor,* Table 19; *D. rotundus,* Table 22; *L. borealis,* Table 25). Male sample means were larger than those of females for the other species in which statistically significant dimorphism was detected (*N. leporinus,* Table 4; *T. silvicola,* Table 8; *P. discolor,* Table 10; *P. hastatus,* Table 11; *A. geoffroyi,* Table 15; *S. lilium,* Table 17; *A. jamaicensis,* Table 20; *N. mattogrossensis,* Table 28; *M. molossus,* Table 29). Clearly, dimorphism for size is common among the Chiroptera, and unlike the situation in many vertebrate orders, females are frequently significantly larger than males. Ralls (1976) summarizes our knowledge of sexual dimorphism in bats in which the females have been implicated to be larger than males while Myers (1978) and Williams and Findley (1979) present additional information on bats in the family Vespertilionidae. Statistically significant dimorphism has only been substantiated for 12 of the 45 potential cases that Ralls reports. Three of the species implicated as having larger females than males either show little size dimorphism (*A. lituratus*) or exhibit statistically significantly dimorphism in which the males are actually larger than the females (*A. geoffroyi* and *A. jamaicensis*) in populations from Brazil. The data for *D. rotundus* and *L. borealis* substantiates Ralls' (1976) claim that females are larger than males in these species. Further, this study adds five different species to Ralls' list of bats in which females are larger than males (*P. macrotis, G. soricina, L. mordax, V. lineatus, A. concolor*).

Most authors agree that both selection pressures consistent with the hypothesis of sexual selection and the "Big Mother" hypothesis affect to greater or lesser extents the observed size relations between the sexes. The data from this study indicates that selective pressures favoring large females are more common than generally perceived for the Chiroptera. Knowledge of bat behaviour and natural history is somewhat limited, but it does *not* suggest a reversal of the theoretical conditions in which males compete among themselves for females (see Bradbury, 1977). Indeed, male bats invest very little in their offspring other than the time and energy involved in copulation (see Kleiman and Malcolm, 1981). In those cases where behaviour patterns have been elucidated, it appears that males compete among themselves for access to reproductive females (Bradbury, 1977). By implication, sexual selection is probably not the dominant factor producing larger females. However, it may well be the factor that reduces the observed differences between the sexes in those cases where females are statistically larger than males. Although Myers (1978) and Williams and Findley (1979) disagree in detail about the particular factors that affect dimorphism in vespertilionids, both attribute the observed differences to biological conditions consistent with the "Big Mother" hypothesis. This study cannot distinguish between the thermoregulatory hypothesis favored by Williams and Findley (1979) and the wing-loading hypothesis of Myers (1978); however, it can qualify some of the contentions they presented. Myers (1978) conjectures that small molossids should show reduced sexual dimorphism (males larger than females) compared to larger species in the family because they share certain flight and feeding characteristics with the Vespertilionidae. In the two species of molossids with sufficiently large samples to permit statistical analyses (*M. molossus* and *N. mattogrossensis*), the males are consistently larger and statistically different than females for both cranial and external characters. Further, *N. mattogrossensis* is one of the smallest members of the Molossidae and it clearly does not exhibit the reduced dimorphism predicted by Myers (1978). Similarly, Williams and Findley (1979) reject Myers' contention by showing that lasiurine bats in the family Verspertilionidae do not exhibit reduced dimorphism (females larger than males) although they would be predicted to do so by Myers' reasoning. The morphometric analyses of *P. macrotis* from the Caatingas are in accord with the observations of Myers (1978) and others (see Bradbury, 1977) for Emballonurids; this small bat is dimorphic with females larger than males. Of course, the proponents of the thermoregulatory hypothesis could also claim that the data supports their position since the demands of thermoregulation are accentuated for small species. Obviously, more data need to be collected from vespertilionid populations occurring along latitudinal or altitudinal gradients to see if species with eurythermal distributions exhibit degrees of dimorphism which are enhanced as temperature decreases.

Although not nearly as pervasive as in the Vespertilionidae, the incidence of sexual dimorphism with females larger than males is also common in the Phyllostomidae (in contrast, see the comments of Bradbury, 1977). Females are larger than males in five of the eleven species exhibiting statistically significant secondary sexual dimorphism. Within the various phyllostomid subfamilies, it appears that smaller species tend to be dimorphic with females larger than males, whereas larger species tend to exhibit dimorphism with larger males. Although Myers (1978) suggests a relation between feeding ecology and dimorphism, little evidence is available to support that position within the Phyllostomidae. The occurrence of dimorphism within a subfamily does not seem to be related to the feeding strategies of the constituent species.

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